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Conseil Permanent International pour l'Exploration de la Mer

CHARLOTTENLUND SLOT — DANEMARK

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ANNALES BIOLOGIQUES

VOLUME NO. XVII

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Scheme for the Arrangement of the Material

I. Review of Investigations and Essential Results

Each Committee Chairman should here give a summary of the contributions received, i.e., a statement of the nature of the material as well as a short review of the position in the area—including the main results obtained—during the last calendar year (unless otherwise stated). This review should only in exceptional cases exceed 2 pages (about 10,000 units of type). Papers should reach the General Secretary not later than 1. May.

II. Tables and Conclusions

A. Environment

1. Strength and direction of currents: Especially data collected during spawning seasons.

2 a. Temperature and salinity conditions: Tables and/or diagrams including anomalies.

2 b. Seasonal temperature variations at selected stations: Data including anomalies.

3. Phosphate concentration, oxygen, etc.: Tables and diagrams to include anomalies.
4. Plankton conditions: Tables and/or diagrams, especially anomalies in distribution of indicator forms, phytoplankton patches, amount of plankton and fat content.
5. Abundance of benthonic food: Data.
6. The main meteorological features of the year: Data especially as to sunlight, rainfall, and direction and force of the wind.

B. The Fish

For each species in the following order: Gadoids (cod, haddock, saithe, others), flatfishes (plaice, dab, flounder, sole, witch, lemon sole, halibut, others), herring, sprat, mackerel, other pelagic fishes, eel, redfish, others.

1. Abundance and distribution of eggs and larvae.
2. Abundance of year-classes: Data derived from experimental hauls.
3. Size- and age-composition of commercial catches or landings.
4. Average length of age-groups: Data from experimental hauls and commercial catches, with standard deviations.
5. Rate of growth: Data from marking experiments and quantitative experimental hauls.
6. Rate of mortality: Data from marking experiments and quantitative experimental hauls.
7. Intensity of fishing: Data as to the fisheries considered in 3, 4, and 8.
8. Quantities landed:—
   (a) Total catch (weight) of special fisheries.
   (b) Percentage of large, medium, and small.
   (c) Total number of the various species.
   (d) Size- and age-composition of commercial catches or landings.

C. Shellfish

Conseil Permanent International pour l'Exploration de la Mer

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SCHMIDT & KLAUNIG, KIEL

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PREFACE

It appears from the **hydrographical section** that the Irminger Current was very much stronger than normal and that the Arctic component of the West Greenland Current was also warmer than usual. Off NW Iceland the ice front was farther off than normal, the shortest distance from the coast in May/June being 60-70 miles. Off the north and east coasts of Iceland, both surface and deep-water temperatures were relatively high. Over the northern North Atlantic the monthly anomalies showed a tendency towards higher temperatures, with only a few exceptions. The western branch of the Norwegian Current was abnormally warm whereas the temperature of the eastern branch remained about normal. During the research work on herring larvae in the North Sea in 1960, a great amount of hydrographical data was collected. The Atlantic water masses flowing into the northern North Sea showed lower temperatures in July 1960 than in July 1959, and over the Dogger Bank the temperature in July was much (2.5°) lower than in July 1959. In the western Baltic the surface temperatures were relatively low throughout the year as compared with the 10-year period 1950/1959.

There is information on **cod** from nearly all the most important subareas. On the West Greenland banks the catches depended mainly on the broods from 1950, 1953, and 1956 whereas the old fish of the 1943 and 1947 year-classes had almost disappeared. It is worth mentioning that spawning accumulations in depths of between 350 and 550 m were observed in March and April. The yields off East Greenland were mainly based upon immature fish, partly very old (11 years and over), and the 1950 and 1953 year-classes were predominant. The 1950 year-class was the strongest one off Iceland, although the 1955 brood seems to be promising. In the Baltic, the 1957 year-class was of greatest importance and the 1959 brood seems to be promising.

Also for **haddock** there are records from nearly all important subareas. It should be noted that young haddock (1—3 year-olds) with a high growth-rate were encountered in the German catches taken off West Greenland where formerly only older fish used to appear. At Iceland the density of haddock had increased considerably owing to the presence of a great number of 4 year-old fish and, partly, also 5 year-olds. The strongest year-classes in other subareas were those of 1956, 1957 (moderate), and 1959 in the Barents Sea and off the Finnmark; 1950, 1953, and 1954 off the Norwegian coast; and 1956, 1957, and 1958 on the Faroese grounds. In the North Sea, the 1955 brood remained very good and that of 1958 was fairly good.

The North Sea **whiting** records showed a predominance of the broods from 1957, 1958, and 1959 the latter for the most part in shallow waters. The 1955 brood showed a relative predominance.

As emphasized in the introduction to the section on **herring,** the Norwegian winter herring fishery showed a new decline. This was partly a result of the failure of recruitment to the spawning stock and partly the abnormal appearance of the herring as to time and place. The fishery started considerably later than usual and took place further north. At North Iceland the summer season yielded considerably less than in the previous year.

As the recruitment to the North Sea fishery was poor, the good 1956 year-class was again predominant although without being able to provide good yields. The yields of the East Anglian fisheries showed a continuous decline. The yield from the German oil herring fishery was less than in 1959, mainly owing to less effort; the landings contained also relatively much young whiting. In the Belgian contribution it is concluded that the herring concentrations in the season of 1960/61 showed greater densities than in the previous season.

The Soviet landings of herring from the north-eastern Baltic indicated, as far as the spring spawners were concerned, that the 1957 year-class was abundant, 1958 was moderate, and 1956 poor.

Attention is drawn to the records on **redfish** and **halibut** in the subarea of the Distant Northern Seas, to a number of data on **flatfish** from the North Sea, **dogfish** taggings carried out by England and Norway, and to a note on the German **sand-eel** fishery. There is also a variety of information on the Baltic Sea. Readers are also referred to the sections on sardine, scombriform fish, salmon and trout, and shellfish.

For further information concerning the fish stocks in 1960, reference is made to the *Statistical News Letters* Nos. 12 and 13. In No. 12 there are detailed records on North Sea herring in 1960, whereas No. 13 contains information on cod, haddock, plaice, redfish, sole, tunny, and whiting.

I would like to express my gratitude to all chairmen and contributors, but I am especially indebted to Mrs. H. Harder of the Council's Publication Department and to her assistant, Mrs. M. Fries, for their unremitting efforts in the preparation of this volume.

Árni Friðriksson

CHAIRMEN'S SUMMARIES OF AREA REPORTS

Distant Northern Seas

Contributions to this report have been received from: —

Denmark:
P. M. Hansen
F. Hermann
J. Smed

England:
J. G. Harvey

Germany:
G. Krefft

Iceland:
U. Stefánsson

Norway:
E. Bratberg

Scotland:
J. H. Fraser
G. T. D. Henderson
J. M. Lamont
T. Lovegrove
B. B. Rae

U.S.S.R.:
A. P. Alekseev
A. A. Degtjarjova
B. V. Istoshin
A. G. Kisljakov
E. A. Pavshtiks
L. R. Shmarina
V. P. Sorokin

I. Hydrography

During the spring and summer of 1960 the ice conditions were favourable in Greenland waters. In April the temperature on the West Greenland banks was somewhat warmer than in April 1959. In July the Arctic component of the West Greenland Current was less developed than normal, whereas the warm Atlantic Current was very well developed. In the region south of Greenland exceptionally high temperatures and salinities were found. This is thought to be due to the Irminger Current having been much stronger than normal during the summer of 1960.

In the period May—June the ice conditions were favourable off the north-west coast of Iceland. Off the west coast of Iceland the temperature was somewhat higher than normal during this period, but exceptionally high off the north coast. In this region higher salinities were found than in any previous year, thus indicating a pronounced Atlantic influx.

In the Norwegian Sea the temperature was also abnormally high throughout the summer, especially in the western branch of the Norwegian Current, the temperature increase being less marked in the eastern branch.

Studies of the monthly anomalies of the surface temperatures in the North Atlantic show that positive anomalies predominate, the yearly average being higher than in 1959. The temperature rise was found to be greatest round Greenland and between Greenland and Iceland.

Of special interest were investigations made on the Iceland-Greenland Ridge revealing a strong and variable bottom current in this region.

It must be concluded that the sea temperature in the Distant Northern Seas Area was abnormally high throughout the summer of 1960, *on the whole probably higher than experienced in any previous year*. These high temperatures seem to be related to an unusually pronounced influence of the Atlantic currents in the different parts of the area.

II. Plankton

Soviet observations on the phytoplankton in the Barents Sea show that the spring outburst occurred in April in this area.

The spawning of *Calanus* in the North Cape/Bear Island area was apparently prolonged and it is thought to be caused by the lack of phytoplankton, which had been utilized by *Phaeocystis pouchetii* occurring there in great quantities.

The warm water species *Collozoum* and *Limacina retroversa* were widely found in the Barents Sea in 1960.

The development of plankton in the mixed waters of the East Icelandic Current was earlier than in recent years.

In Faroe waters the spawning of *Calanus* started in April, which was in accordance with the increasing influx of warm water in this area. As a result of this, the herring which migrated into this area in April, missed the large and adult *Calanus*.

The herring in the East Icelandic Current reached their maximum fat content in June/July, which is much earlier than in the previous colder years.

Scottish investigations show that the spring outburst of phytoplankton occurred in May in the Faroe-Shetland Channel. A flow of oceanic water to the west of the Faroes is suggested by some phytoplanktonic evidence.

The Scottish report also discusses the distribution of zooplankton in the Faroe-Shetland Channel in the course of the year.

The sampling with Continuous Plankton Recorders was continued by the Edinburgh Oceanographic Laboratory on a line extending to the Newfoundland Banks from Iceland. Young redfish

which all appeared to be *Sebastes marinus* were caught in the months April to July and the distribution of these is given. The size distribution of *S. marinus* in 1960 is compared to those for the years 1955—59, and in all years it seems to fit a common growth curve, representing one single population.

III. The Fish

The sex composition of the *Sebastes mentella* in the Kopytov area shows a marked difference from one period to another and this has been used by Soviet workers to study the migration pattern of this species. A delay in the migration of the males to this area in 1960 very much affected the yield of the fishery. The main reasons for the differences in the onset of these migrations are thought to be the temperature on the feeding grounds and the intensity of the winter cooling of the sea.

In the Godthåb Fjord, Danish workers tagged 281 large redfish with Petersen discs. These fish were caught in pound nets or with a big jig.

Norwegian investigations on the halibut in West Greenland waters indicate that the mature halibut migrates from the shallow and cold waters to deeper and warmer waters during the year, whereas the immature halibut probably remain on the upper slopes of the banks throughout the year.

Lists of rare fishes caught on the banks off the Faroes, Iceland and Greenland are given by Germany and Scotland.

JÓN JÓNSSON

Near Northern Seas

Contributions to this report have been received from:—

Denmark:
K. P. ANDERSEN
AA. J. C. JENSEN
K. POPP MADSEN
J. SMED
G. STOUGÅRD NIELSEN

England:
M. J. HOLDEN
A. J. LEE

Germany:
E. GOEDECKE
A. KOTTHAUS
P. F. MEYER-WAARDEN
E. H. ROGALLA

Netherlands:
J. A. VAN DUIJNEN-MONTIJN
L. OTTO
K. H. POSTUMA
J. F. DE VEEN
J. J. ZIJLSTRA

Norway:
O. AASEN

Poland:
J. FILARSKI

Scotland:
R. B. BURNS
J. M. COLEBROOK
R. E. CRAIG
J. H. FRASER
R. S. GLOVER
R. JOHNSTON
J. M. LAMONT
T. LOVEGROVE
B. B. RAE
G. A. ROBINSON

Sweden:
A. SVANSSON

I. Hydrography

A considerable amount of hydrographical information has been collected in the Near Northern Seas area on the occasion of the International Surveys under the auspices of the Herring Committee. A general outline of the hydrographical observations made in March/April 1960 is presented in a joint paper. The eastern winds prevailing at that time exerted a considerable influence on the hydrographical pattern. These winds drove Baltic and continental coastal water far in western direction. The track of Atlantic Channel water, breaking up in several eddies, could be observed. In the region of the Norwegian Trough, discontinuity layers developed at the depth of 20—50 m, leading to steep gradients.

A second joint paper deals with the international hydrographical observations made in September/October 1960. Synoptic charts of temperature and salinity patterns are added. The westward thrust of continental water observed in spring had disappeared by now. Data collected in international co-operation in the southern North Sea and in the English Channel during the month of January 1960 are presented in an additional paper. The data charted is to be considered the preliminary result of the joint observations, giving an insight in water movements, which can affect the migration of herring fry.

Additional Scottish data reveal that surface salinities were low throughout the year. In October a well marked intrusion could be observed in the bottom layers, to be destroyed later by vertical mixing. Water temperatures were above average.

The mid-summer pattern of the North Sea hydrography is presented in a paper summarizing observations made by the fisheries research vessel "Anton Dohrn". North Atlantic water, typical North Sea water, and low-salinity water of Baltic and continental origin could be clearly distinguished. Several cores of cold bottom water could be identified, and discontinuity layers north of the Dogger Bank were charted.

Additional mid-summer data are presented in

the paper dealing with the observations made in the central North Sea by the fisheries research vessel "Willem Beukelsz". The temperature stratification over and north of the Dogger Bank is clearly shown in two cross sections.

Polish observations in the central North Sea pay special attention to the temperature conditions in the bottom layers, which were lower in 1960 than in 1959. A great number of figures accompanies this paper.

The German temperature and salinity observations in the surface layers on the Hamburg—Hull route were continued. Monthly deviations from long-term means are given. High water temperatures in the majority of the months, but cold in July, are explained in terms of weather conditions; high salinities as a consequence of a strong influx of Atlantic water and of a precipitation deficit.

Again, temperature and salinity observations were made from 5 German lightships. Here, too, surface temperatures appeared to be above normal during most of the months, but low in mid-summer, whereas salinities were also higher than usual, but rather low towards the end of the year. The deviations from the long-term means are ascribed to the unusual weather pattern in the year 1960.

Again, thermograph recordings are presented for the North Minch, which did not deviate much from the usual pattern.

Surface temperatures deviated little from the normal pattern in the Kattegat, but bottom temperatures were more irregular. Here, too, the surface salinity was unusually high during the first half of the year, but low in October.

Chemical observations made in the North Sea in November 1959 and late in 1960 indicate a late winter overturn and a strong oceanic influx of water late in 1959, whereas autumn 1960 was characterized by a normal winter overturn, a feeble oceanic incursion, and below average nutrient conditions. Data on phosphate, oxygen, silicate, and nitrate content are presented.

II. Plankton and Benthos

Plankton investigations from Aberdeen give an insight in the fluctuations in abundance in the course of the year for various phytoplankton organisms. The general impression is that the sequence of events was close to normal in 1960, the spring outburst being slightly late, the numbers of organisms were, however, much lower than usual.

Observations of zooplankton organisms demonstrated that the year 1960 was characterized by a poor inflow of oceanic plankton in the northern North Sea via Shetland, although oceanic communities were abundantly evident at the western entrance to the Faroe-Shetland Channel.

The Continuous Plankton Recorder was again used to study the plankton around the British Isles at monthly intervals. The presentation of the results has been modified, the area covered having been subdivided into a number of subareas to facilitate comparison with fisheries statistics and hydrographical data. Long-term means are presented for each month in each subarea for the period 1948/1959.

The spring outburst of phytoplankton appeared to be late in the area over the deep Atlantic; further peaks were of late occurrence, too, in this area. In the North Sea and over the continental shelf the spring outburst, as usual, occurred a month earlier than in the Atlantic. The numbers of total copepods were close to the average in most areas, but deviations from the normal pattern are recorded for some species of copepods. Some species of pteropods reveal a change in their distribution pattern, shifting from oceanic water to the continental shelf and the northern North Sea. A striking feature was the appearance of the pteropod *Pneumodermopsis paucidens* over the continental shelf and in the north-western North Sea. The impression is gained that the oceanic plankton west of the continental shelf has become progressively less distinguishable from that of the north-western North Sea in the past eight years or so. The 1960 plankton yielded no evidence of oceanic incursions into northern North Sea.

III. The Fish

The results of German sole tagging experiments are presented. Soles tagged in the German Bight in the summer of 1960 migrated predominantly in westward direction. Survival rates appeared to depend on the condition of the fish at tagging. In drawing conclusions on growth-rates, the possibility of a deficient growth during the first months after tagging must be taken into account.

Dutch investigations on age composition of the plaice population in the southern North Sea demonstrated a striking difference between males and females in the decline in numbers of the subsequent year-classes; also, in the case of males, between the Southern Bight and the German Bight. This phenomenon is explained in terms of a much heavier fishery on the German Bight

spawning ground, and of a shorter sojourn on the spawning ground by the female plaice.

The Danish investigations on flatfish in the Skagerak-Kattegat area were continued. The 0-group plaice was below normal in northern and central Kattegat, but of normal strength in the southern Kattegat, whereas high figures were found in the vicinity of the Swedish coast. In the deeper water of the Kattegat, II- and III-group plaice dominated in the catch; a considerable number of I-group plaice was observed in the deeper water of the central Kattegat. Data on the commercial catches of plaice in Skagerak and Kattegat are presented.

Norwegian results of dogfish tagging are reported. Most of the tagged fish appeared to have moved towards the Norwegian coast in winter and back to the grounds north-west of the British Isles in summer. Recapture data indicate that a substantial portion of the dogfish stock did remain in Norwegian waters throughout 1960.

British investigators tagged dogfish in the Irish Sea. Recapture data reveal migration in both northerly and southerly direction.

It is reported from Germany that the 1960 sand-eel fishery was of little importance only, due to the worldwide drop in fishmeal prices. Nearly 60% of the yield was obtained in June. Data on analysis of samples are presented. Again, *Ammodytes lancea marinus* was by far the predominant species in the German fishery.

Lists of rare fishes recorded in Germany, Scotland, and the Netherlands are presented.

P. Korringa

Baltic-Belt Seas

Contributions to this report have been received from:—

Denmark:
Aa J. C. Jensen
H. Thomsen

Germany:
E. Goedecke
R. Kändler
J. Krey

Poland:
W. Cieglewicz
A. Glowinska
S. Kujawa
W. Mankowski
J. Netzel
Z. Reimann
D. Zembrzuska
L. Zmudzinski

Sweden:
Stig H. Fonselius

U.S.S.R.:
J. J. Nikolaev
Kh. K. Krievs
N. J. Ryapolova
A. T. Shurin
K. A. Zemskaya
V. Erm

I. Hydrography

Danish, German, and Polish observations on the monthly anomalies of the surface temperatures indicate that the summer of 1960 was rather cold. Goedecke considers July 1960 as one of the coldest summer months of the last 40 years. According to Glowinska, the bottom temperatures in Bornholm Deep, at the beginning of 1960, was much lower (3.3°C) than usual; in the southern Gdansk Deep, however, it was much higher (8.3°C). Later on it gradually became normal (5.5°C), as observed in October and November. Observations on the salinity and oxygen content indicate that normal conditions were restored due to renewal of the bottom waters by influx of more saline waters from the North Sea.

II. Plankton and Benthos

According to Krey, the yearly mean value of the planktonic microbiomass and detritus per m^2 (dry weight) in Kiel Bay were in 1960 higher than the average values for 1958/60. Nikolaev and Krievs have, however, found that the biomass of zooplankton in the central and northern parts of the Baltic, particularly in deeper layers, was lower than the long-term average. This phenomenon, together with low temperatures in the intermediate water layers have created unfavourable feeding conditions for herring and sprat in this region.

Shurin observed in 1960 a reduction in the distribution of bottom fauna in the northern part of Gothland Deep, and the biomass of *Macoma baltica* and *Cardium edule* was also reduced. In the eastern Baltic and in the Gulf of Riga, great amounts of molluscs were lost during the winter 1959/60 on account of the low water level and the formation of a thick layer of coastal ice.

Mankowski presents a list of macroplankton species which are indicators of inflow of saline North Sea waters into the Baltic. Among these species the medusa *Melicertum octocostatum* appeared only in years when the salinity of the bottom water was higher than $16^0/_{00}$.

Zmudzinski deals with the occurrence of the mysid *Praunus enermis* (Rathke) in the coastal waters of Puck Bay.

Zembrzuska gives an account of the phytoplankton in the Firth of Szczecin.

III. The Fish

The number of dab and sprat eggs, recorded by KÄNDLER was higher in the 1960 spawning season near the "Fehmarnbelt" lightvessel, but that of mackerel was lower than in the foregoing year.

The density of young flatfish was examined by means of the Johansen young-plaice trawl in the coastal waters of the Belts and the Sound and by hand push-net in the Baltic. The 1960 year-class of plaice, flounder, turbot, brill, and sole was for the most part poorer than in the previous year, while the 1959 year-class of these species was above average, as stated by JENSEN.

In the southern Baltic, REIMANN found that the number of 0-group plaice was lower than last year, while rather higher numbers of 0-group flounder and turbot were encountered.

The results of experimental fishing with the standard trawl, presented by JENSEN and KÄNDLER, indicate that the 1959 year-class of plaice seems to be very rich in the Belts and in the western Baltic.

German investigations show that the 1959 and 1960 year-classes of cod were very frequent.

According to NETZEL, the number of young flounder, 10 to 24 cm in length, caught in Gdansk Bay with the standard trawl was in 1960 much higher than in the foregoing year.

The Polish flatfish fishery, described by CIEGLEWICZ, has shown a further small increase in the landings, a feature already observed in 1959. The average length of the flounder was 27 cm, and age-groups III and IV were predominant.

A note on a sturgeon caught in the Firth of Vistula is presented by KUJAWA. Data on the catches and population dynamics of the lamprey in the rivers of the Latvian SSR are given by RYAPOLOVA. Biological data on pike-perch and silver bream in the Bay of Pärnu are presented by ERM.

The Danish catches of silver-eel in the Belts, Sound, and Baltic were above normal.

W. CIEGLEWICZ

PART I.

HYDROGRAPHY

A. Distant Northern Seas

Hydrographic Conditions in Greenland Waters during August 1960

(Figures 1–6)

During a cruise of the English research vessel "Ernest Holt" to Greenland waters in August 1960 hydrographic observations were made in the Denmark Strait and on a section south-west from Cape Farewell.

Figure 1 shows the surface temperature distribution and position of the ice front in the Denmark Strait between 14. and 21. August, and the location of the Iceland-Greenland Section. The temperature and salinity distributions along the Iceland-Greenland Section on 15. and 16. August are shown in Figures 2a and 3a. On 16. August at the conclusion of this section the "Ernest Holt" returned to the position, as near as could be determined, of station IG7 to anchor in 550 m depth (station 33) and make direct measurements of the current near the bottom. It was found that the bottom temperature was now 0.1°C; this was 2.4°C lower than that recorded at station IG7 20 hours earlier. Bottom current observations were made throughout a tidal cycle with the Carruthers' Pisa Current Indicator, showing a mean residual current of 0.3 knot in a direction 250° true. In order to delimit the extent of the cold bottom water encountered at station 33 the part of the Iceland-Greenland Section in the immediate vicinity was repeated on 17. August. Figures 2b and 3b show the results of this.

A comparison of Figures 2a and 3a with 2b and 3b shows that two major changes took place in the section during the short time interval of less than two days. The front separating the warmer saline water of Atlantic origin from the cooler fresher water of northerly origin moved a considerable distance towards the east-south-east, and there was a strong influx of Norwegian Sea deep water of sub-zero temperature and salinity 34.92‰ against the continental slope of Greenland. The marked fall in bottom temperature between station IG7 and station 33 was the result of this influx of Norwegian Sea deep water, and the current measurements at station 33 show it to have been moving approximately parallel to the bottom contours along the continental slope. Three other water masses are present in both sections, namely the Atlantic water of the Irminger Current (temperature 7°C, salinity 35.2‰), the Polar water of

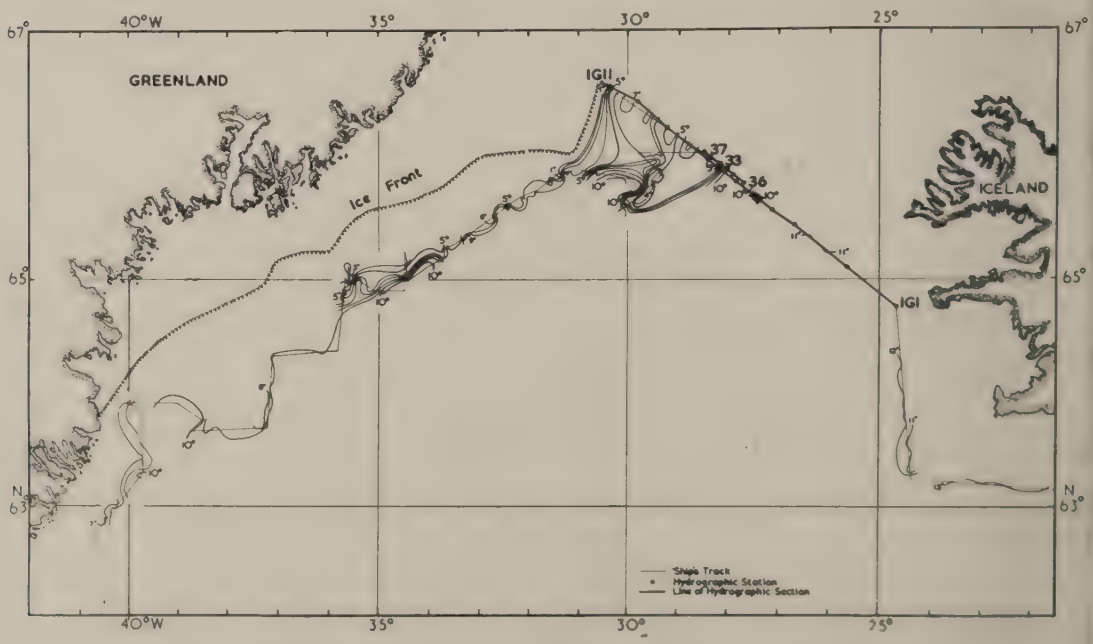


Figure 1. Surface temperature distribution in the Denmark Strait (°C), 14.—21. August 1960.

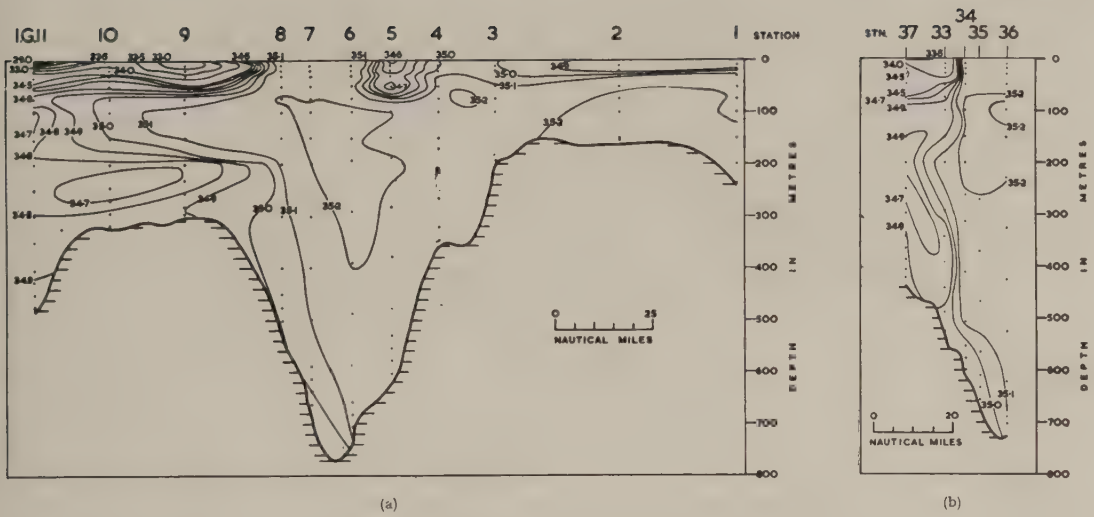


Figure 2. Temperature distribution on the Iceland-Greenland Section (°C).
(a) 15.—16. August 1960; (b) 17. August 1960.

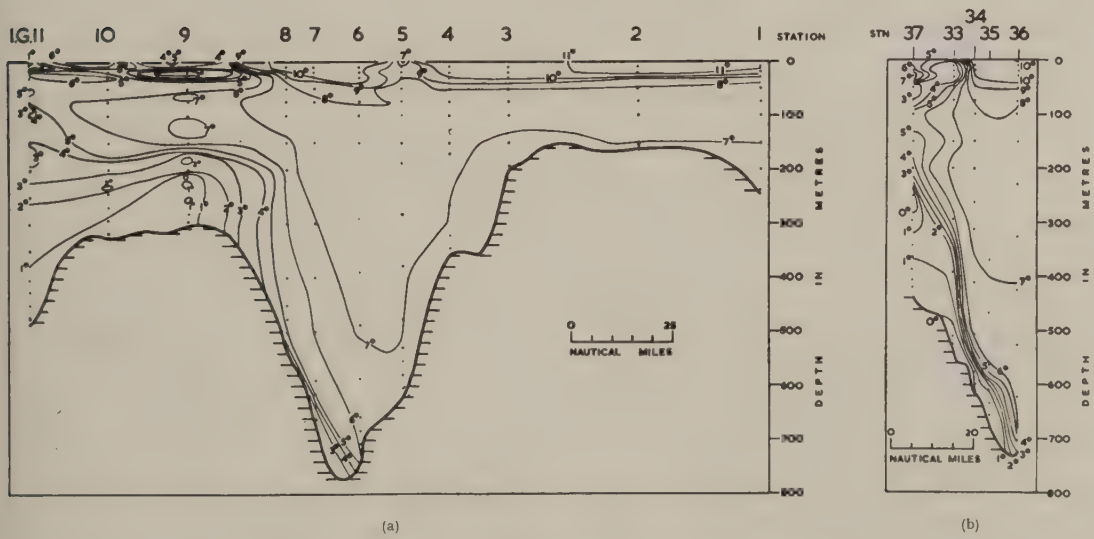


Figure 3. Salinity distribution on the Iceland-Greenland Section (‰).
(a) 15.—16. August 1960; (b) 17. August 1960.

the upper layers of the East Greenland Current (salinity < 34.0‰) and the Arctic Intermediate water of the south-going undercurrent (temperature 1°C, salinity 34.9‰). These water masses have, however, been subject to considerable modification by warming and dilution at the surface, and by intermixing.

Bottom temperature and salinity observations made in conjunction with a fish survey on the banks to the west and south of the section are shown in Figure 4. The advancing front of the cold Norwegian Sea deep water is apparent and also the cold water covering the floor of the Store Fjord. At station IG11 on the eastern side of the fjord the

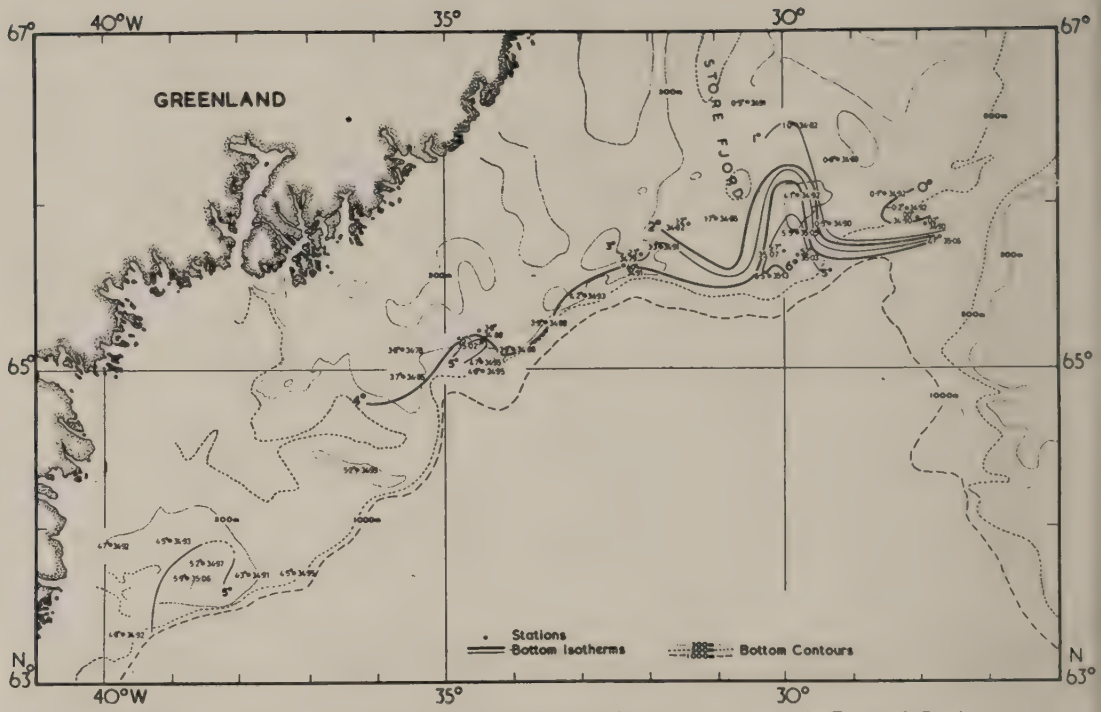


Figure 4. Bottom temperature (°C) and salinity (‰) observations in the Denmark Strait, 16.—21. August 1960.

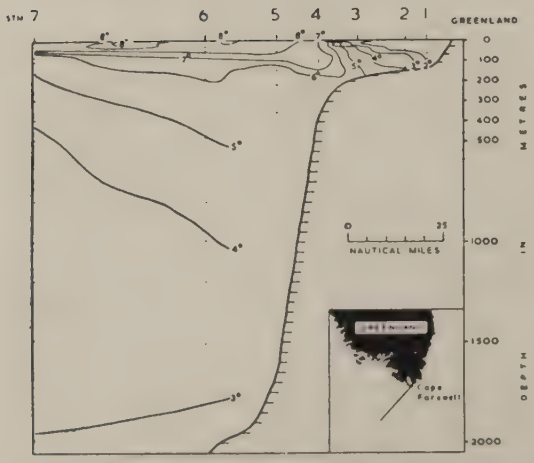


Figure 5. Temperature distribution on the Cape Farewell Section (°C), 26.—27. August 1960.

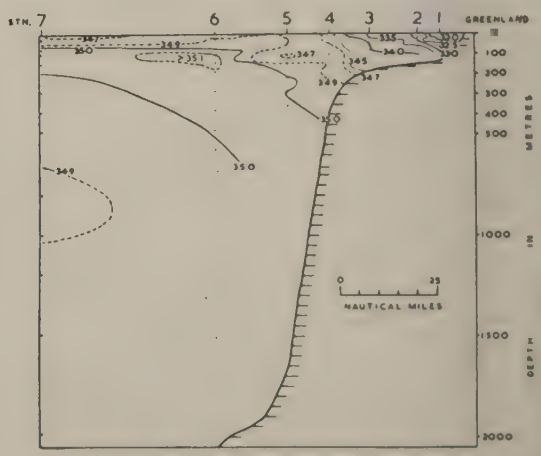


Figure 6. Salinity distribution on the Cape Farewell Section (‰), 26.—27. August 1960.

water from 427 m to the bottom (486 m) shows the T-S characteristics of Norwegian Sea deep water, This must be water of an earlier overflow from the Norwegian Sea which had been deflected into the fjord by the Coriolis effect. On the western side, where the bottom is at less than 400 m depth, Arctic Intermediate water was found.

The very considerable changes found to occur in a period of two days in this region show that observations at one point of time cannot be taken to indicate the conditions prevailing during any longer period. Hence no attempt is made to compare the conditions found in the Denmark Strait by the "Ernest Holt" in August 1960 with those found in previous years by other workers.

A section from Cape Farewell towards the southwest was worked on 26. and 27. August. Near-gale force winds from between north and east hampered the work considerably, preventing observations being made down to the bottom at some stations, in particular at station CF5. The temperature and salinity distributions are shown in Figures 5 and 6.

Sections have been worked along this line southwest from Cape Farewell regularly by the U. S. Coast Guard in the months June to September since 1928. When compared with the conditions in previous years the most notable feature of those found in August 1960 by the "Ernest Holt" is the remarkably high salinity observed between 100 m and 187 m at station CF6 and indeed the generally high salinities in the upper 500 m at all the offshore stations. The maximum salinity recorded was 35.104‰ at 140 m at station CF6. The area of maximum salinities is also characterized by particularly high temperatures. Apart from 1933, when the salinity observations were thought to be in error, the highest salinity recorded by the U. S. Coast Guard in any of their 22 observations along this section between 1928 and 1959 was a value of 35.07‰ observed in both August 1931 and July 1934. Between 1928 and 1948 ten observations were made, apart from that in 1933, and the maximum salinity observed on each occasion varied between the limits 35.02‰ and 35.07‰. Between 1949 and 1958 one observation was made every year and the maximum salinity on each of these ten occasions varied between the limits 34.925‰ and 35.01‰.

The particularly warm and saline water found in August 1960 must be of Atlantic origin and is almost certainly the result of the Irminger Current being very much stronger than normal, with perhaps the direct contribution of water from the outer margins of the North Atlantic eddy also being greater than normal. The increase in the strength of the Irminger Current might possibly indicate a return to pre-war conditions (the maximum salinity of 35.03‰ observed by the U. S. Coast Guard on this section in August 1959 having been the highest which they had observed here since 1948), or it might have been a short-term feature resulting from the strong northerly and easterly winds experienced during the period when the section was worked.

The Arctic component of the West Greenland Current was also warmer than normal, and the bottom temperature over the greater part of the bank exceeded 4°C.

J. G. Harvey

Norwegian Investigations off West Greenland in 1960

(Figures 7–8)

The Norwegian R. V. "G. O. Sars" made a cruise to the waters off West Greenland between 28. March and 6. May. The actual time spent on the West Greenland banks was in the period 4.—26. April.

Compared with 1959 the ice conditions were good, but bad weather hampered the work very much. Between 5. and 24. April five hydrographical sections were worked. In addition, 17 temperature registrations were made, most of them by means of bathythermograph readings in conjunction with fish surveys.

The hydrographic sections were between the following positions:—

	N	W		N	W
Noname Bank — west	61°41′,	49°40′	—	61°24′,	51°51′
Frederikshaab Bank — west	62°12′,	50°24′	—	61°57′,	52°01′
Dana Bank — west	62°50′,	50°47′	—	62°33′,	52°26′
Fylla Bank — west	63°58′,	52°30′	—	63°45′,	54°09′
Banana Bank — west	64°31′,	52°45′	—	64°26′,	54°55′

The isotherms on two of the sections are shown in Figures 7 and 8. The temperatures showed no exceptional features compared with those of April 1959.

As usual the Arctic component of the West Greenland Current was well developed, and thus the cold Arctic water with temperatures below 2°C characterized the surface layers and penetrated down to the top of the banks. The offshore slopes of the banks, that is below 90—150 m, were covered with water of Atlantic origin and this water also

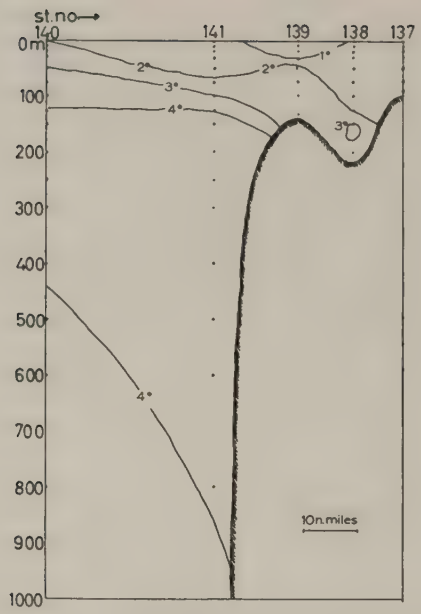


Figure 7. "G. O. Sars", West Greenland, April 1960. Temperature section Noname Bank — west.

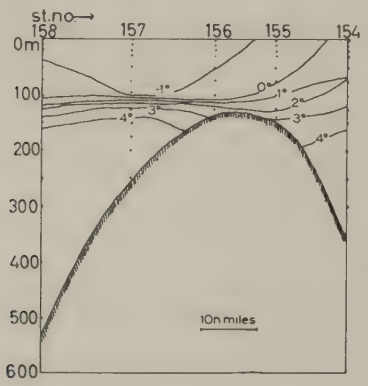


Figure 8. "G. O. Sars", West Greenland, April 1960. Temperature section Banana Bank — west.

characterized the intermediate waters in the area investigated.

When comparing the temperatures in 1960 with those of April 1959, it might be concluded that the water masses off West Greenland were warmer in April 1960 than in April 1959. This change in temperature, however, was probably not due to a change in the main hydrographical situation. It is more likely that it was a temporally change due to heavy turbulence caused by the force of the constantly blowing winds.

ERLING BRATBERG

Hydrographic Conditions off West Greenland, July 1960

(Figures 9–13)

Figure 9 shows the positions of the hydrographic sections worked by M/C "Adolf Jensen" and M/C "Sujumut" in July 1960. The temperature distribution at 50 m is also shown. The hydrographic situation is further illustrated by Sections I, II, and III in Figures 10—12.

The observations show that the Arctic component of the West Greenland Current as usual was encountered off the slope of the banks. This component was, however, not very well developed and the minimum temperatures in its core were higher than usual. The warm Atlantic component of the current, which is mainly found as an undercurrent, was very well developed and carried water with temperatures above 4°C as far north as 67°N.

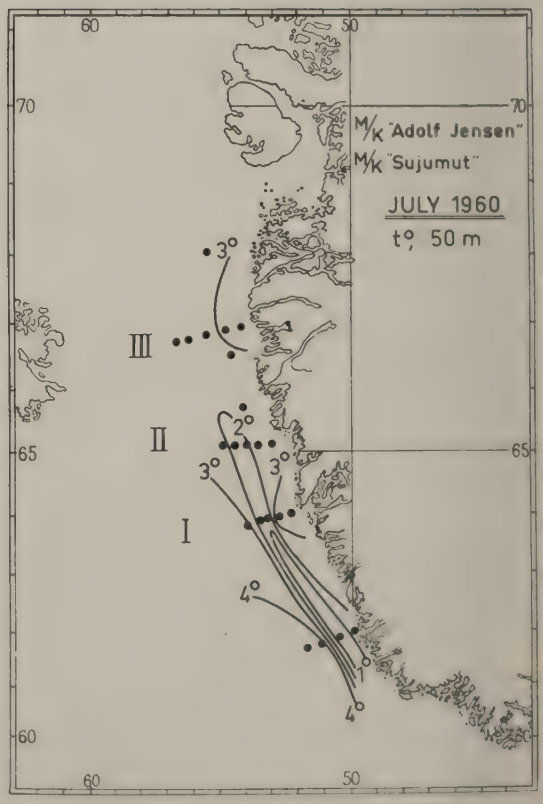


Figure 9. Location of stations and distribution of temperature, July 1960.

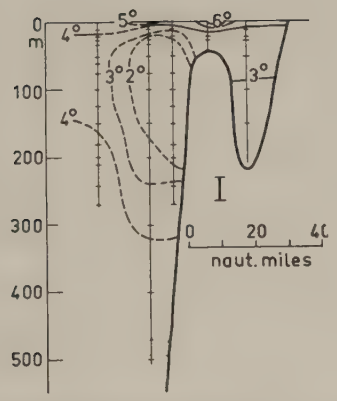


Figure 10. Section across Fylla Bank, 12. July 1960

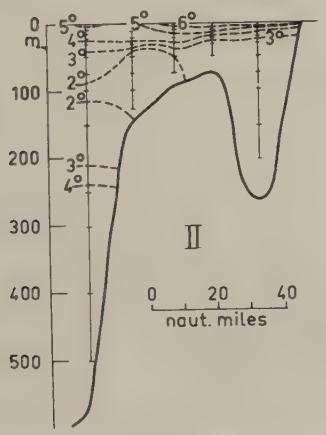


Figure 11. Section across Lille Hellefiske Bank, 13.—14. July 1960.

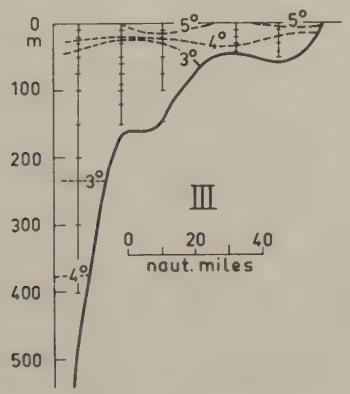


Figure 12. Section across Store Hellefiske Bank, 17. July 1960.

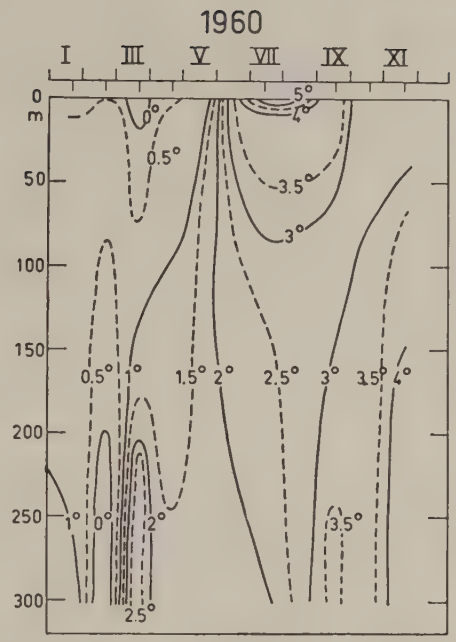


Figure 13. Variation of temperature at the entrance to Godthåb Fjord during 1960.

Off West Greenland the temperatures were thus very favourable at this time and probably the highest found during the last ten years.

In April and June the Fylla Bank Section was worked by M/C "Adolf Jensen" and at this time of the year the temperatures were also higher than usual. Over the shallow part of Fylla Bank (40 m) the temperature on 30. April was thus 1.6°C and on 30. June it was 2.6°C.

The station at the entrance to Godthåb Fjord (64°07'N, 51°53'W) was worked eight times during 1960. The variation of the temperature throughout the year in this locality is shown in Figure 13. The figure shows that an inflow of cold bottom water with sub-zero temperatures took place in February but apart from this short period warm conditions prevailed; especially in November a strong inflow of warm bottom water seems to have taken place.

FREDE HERMANN

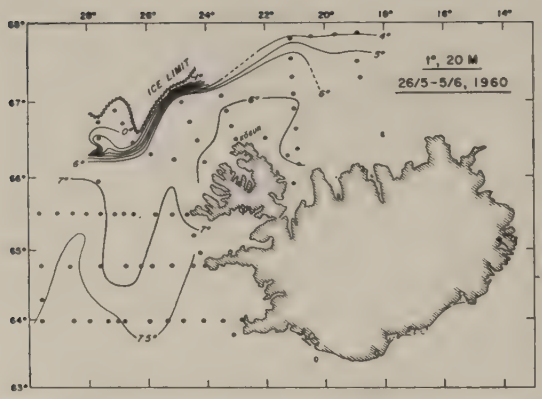


Figure 14. Temperature, 20 m, 26. May to 5. June 1960.

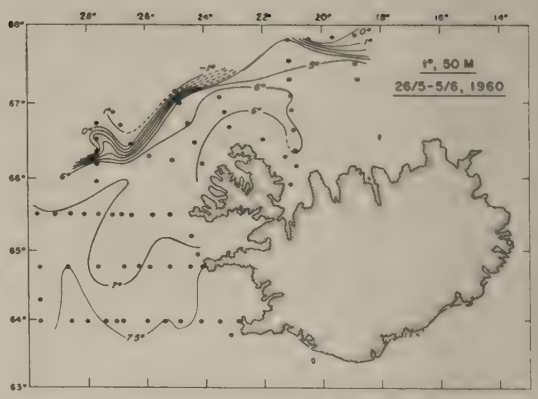


Figure 15. Temperature, 50 m, 26. May to 5. June 1960.

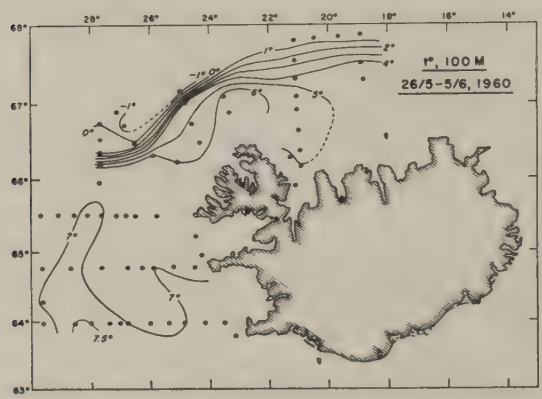


Figure 16. Temperature, 100 m, 26. May to 5. June 1960.

Figure 17. Temperature, 20 m, 11. to 23. June 1960

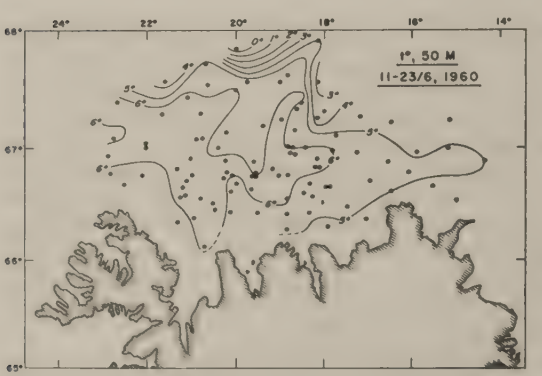


Figure 18. Temperature, 50 m, 11. to 23. June 1960.

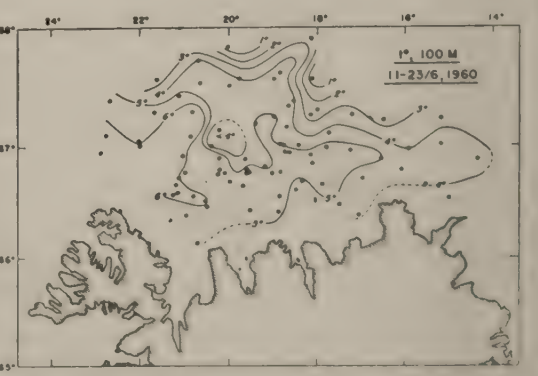


Figure 19. Temperature, 100 m, 11. to 23. June 1960.

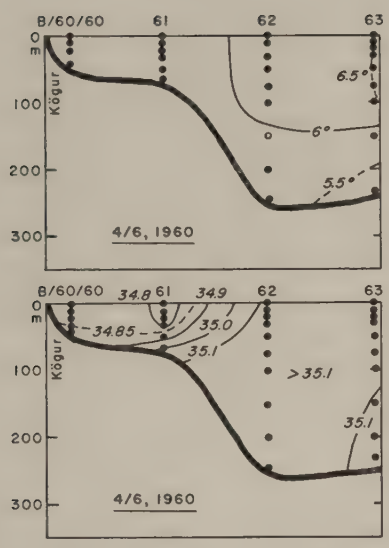


Figure 20. Section north-north-west of Kögur. For location, see Figure 14.

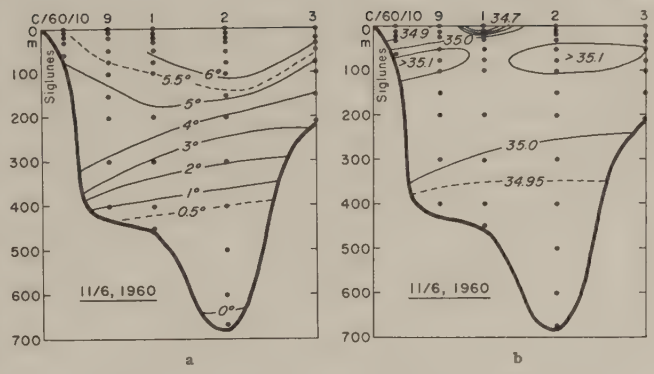


Figure 21. Section north of Siglunes; (a) temperature; (b) salinity. For location, see Figure 17.

The sections off Kögur and Siglunes (Figs. 20 to 21) show clearly that the high temperatures and strong Atlantic influence also prevailed in the deeper water layers. On the section off Siglunes (Fig. 21 b) higher salinities were found in June 1960 than in any previous year.

UNNSTEINN STEFÁNSSON

Hydrographic Conditions in Icelandic Waters in May/June 1960

(Figures 14–21)

Hydrobiological surveys were carried out in the waters west and north of Iceland in the periods 26. May to 5. June and 11. to 23. June. Figures 14—19 show the location of the stations worked and the temperature distribution at 20 m, 50 m, and 100 m. The temperature data consisted of BT observations except for two hydrographic sections, north-north-west of Kögur (Fig. 14) and north of Siglunes (Fig. 17).

The drift ice was farther off the north-west and north coasts of Iceland than normal. The shortest distance from Cape Kögur (see Fig. 14) to the ice front was 60—70 miles.

The temperatures off the west coast at 20 and 50 m depth (see Figs. 14—15 and 17—18) were 0.5°—1° higher than normal. At 100 m depth off the west coast the temperature was about normal, but off the north coast it was 1°—2° higher than normal. Comparison with previous years shows that the temperature was higher in May/June 1960 than in any year since 1954. The relatively highest temperatures were found off the north-east coast, thus indicating a pronounced influence of Atlantic water.

Monthly Anomalies of the Surface Temperature in Areas of the Northern North Atlantic in 1960

(Figures 22–24; Tables 1–2)

On the basis of data collected in 1960 by the Danish Meteorological Institute from Danish and Icelandic ships in the northern North Atlantic anomalies of surface temperatures have been evaluated for each month and each 1°-square, using RYDER's grand monthly means for the period 1876 to 1915 as standards. These anomalies were then averaged over the areas indicated in Figure 22.

The results are given in Table 1 where the monthly anomalies are recorded, together with the numbers of observations on which they are based. In the last column of the table the monthly anomalies for each area have been averaged for the year.

Table 1 shows that positive anomalies still predominate during 1960. Thus, for all areas except the two southernmost ones (E and N) the yearly averages of monthly anomalies are positive, as seen from the last column of Table 1. The distribution of these yearly anomalies over the region is shown in Figure 23. Evidently, the anomalies are highest in the northern and eastern parts of the region.

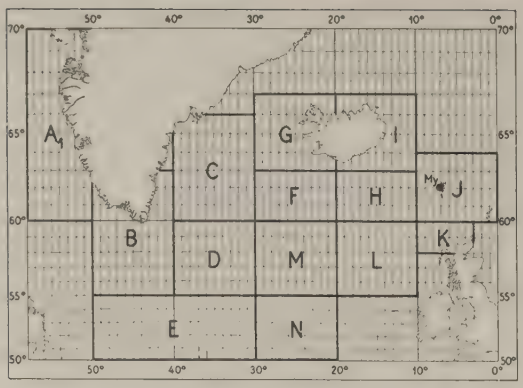


Figure 22. Location of areas A_1 to N and of station My.

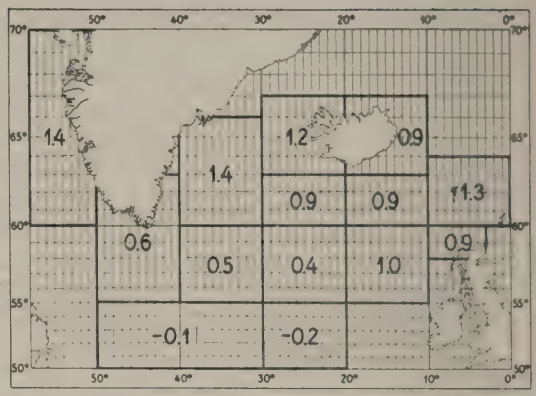


Figure 23. Anomalies of surface temperature (°C) for 1960.

Table 1. Monthly anomalies (△°C) and numbers (n) of observations of the surface temperatures in the areas A_1 N (see Figure 22) during 1960

	Jan.		Feb.		March		April		May		June		July		Aug.		Sept.		Oct.		Nov.		Dec.		Aver.
	△	n	△	n	△	n	△	n	△	n	△	n	△	n	△	n	△	n	△	n	△	n	△	n	of △-val.
A_1	—	—	—	—	—	—	1.5	42	1.2	110	1.2	94	1.6	74	1.2	55	1.4	40	1.8	60	1.1	5	—	—	1.4
B	—	—	—	—	0.5	27	0.4	60	0.8	88	0.9	54	1.0	54	0.6	59	0.2	50	1.1	28	0.7	26	−0.3	4	0.6
C	—	—	—	—	1.0	11	0.3	19	0.7	12	1.3	14	1.7	47	2.5	34	0.8	60	1.9	17	2.2	4	—	—	1.4
D	0.6	2	—	—	0.4	29	0.6	33	0.6	52	0.3	28	0.2	19	0.9	21	0.6	24	1.1	21	0.8	19	−0.6	9	0.5
E	−0.6	21	0 2	20	−0.5	16	−1.0	18	−0.2	25	−0.9	46	0.1	29	1.2	28	0.2	43	−0.3	30	−0.2	22	0.3	37	−0.1
F	—	—	—	—	1.0	18	0.4	61	1.0	47	0.9	33	0.9	48	1.2	43	1.0	45	1.6	23	0.8	22	0.2	6	0.9
G	0.8	3	—	—	—	—	—	—	—	—	1.4	13	1.1	42	1.3	12	1.2	27	1.7	37	—	—	—	—	1.2
H	0.1	9	0.9	4	0.8	25	0.8	57	1.5	49	1.4	53	1.1	69	1.1	70	0.9	46	1.0	43	0.6	25	0.6	11	0.9
I	−0.7	3	—	—	—	—	—	—	—	—	—	—	1.2	7	2.0	8	—	—	1.2	1	—	—	—	—	0.9
J	0.8	12	1.3	6	1.2	12	1.2	28	1.3	24	1.7	25	1.4	48	1.4	53	1.2	24	1.2	28	1.4	17	1.0	6	1.3
K	0.7	11	0.5	20	0.5	22	0.8	28	1.5	26	1.6	25	1.1	36	1.0	28	0.7	33	0.7	19	0.7	22	1.1	23	0.9
L	0.8	15	0.2	26	0.8	28	0.9	22	1.3	31	1.4	32	1.4	23	1.0	28	0.9	27	1.0	17	1.4	25	0.8	28	1.0
M	0.6	17	0.6	25	0.4	34	0.2	17	0.2	23	0.2	30	0.5	22	0.5	26	0.4	30	0.6	26	1.0	28	−0.1	39	0.4
N	−0.2	3	−0.4	3	0.2	2	−0.6	5	−0.4	10	−0.8	8	−0.4	6	—	—	−0.3	1	−0.2	1	—	—	0.6	1	−0.2

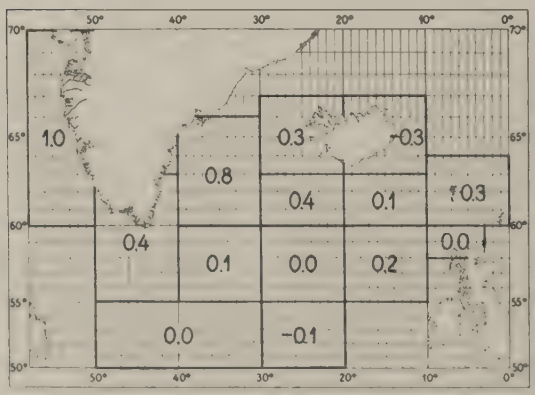


Figure 24. Variation of surface temperature (°C) from 1959 to 1960.

Table 2. Grand monthly means of the surface temperature (°C) at Myggenæs, Faroes (My in Figure 22) during the period 1914–1950 and deviations for 1960 from these means

	Jan.	Feb.	Mar.	April	May	June
Means 1914–50	6.3	6.0	5.9	6.3	7.1	8.2
Deviations 1960 ..	1.0	0.2	0.7	0.9	1.0	1.0

	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Means 1914–50	9.3	9.8	9.7	9.1	7.9	7.0	7.7
Deviations 1960 ..	1.0	0.9	1.0	1.0	1.2	0.8	0.9

The average of the yearly anomalies given in the last column of Table 1 is 0.8° C, which is 0.2° C higher than in 1959. Figure 24 shows the geographical distribution of the variation of temperature from 1959 to 1960. It appears that there is a tendency towards higher temperatures over the whole region except in the southernmost part of it and at the eastern part of Iceland (area I). As seen from Table 1 the material from the last mentioned area is very scanty in 1960, however. Much importance could, therefore, not be attached to the temperature decline found in this area. The temperature rise is greatest round Greenland and between Greenland and Iceland.

Table 2 gives the grand monthly means of the surface temperature at Myggenæs, Faroes (Station My in Figure 22) for the period 1914—1950, together with the deviations of the 1960 values from these means. The average of the monthly deviations is 0.9° C which means a rise from 1959 of 0.2° C.

I am indebted to Messrs. I. Sestoft, H. Thomsen and G. Stougård Nielsen of the Danish Meteorological Institute for placing the data at my disposal before publication.

Jens Smed

Erratum

Annales Biologiques, Vol. XVI, p. 22. Figures 22, 23 and 24 should be numbered 21, 22 and 23 respectively, in order to be in accordance with the numbering used in the text.

Hydrographic Conditions in the Norwegian and Greenland Seas in the Summer of 1960

(Figures 25–27)

At the end of 1958 an increase of the influx of Atlantic water into the Norwegian Sea started, causing a rise in the temperature in the southern part of the sea.

In June 1959, during the oceanographic survey carried out according to the joint plan of four countries, the spreading of the temperature rise up to 72°50′N was stated. The rise in temperature most strongly affected the waters of the eastern branch of the Norwegian Current where the temperature rose above normal on all sections. The middle and western branches were affected to a less degree, the anomalies on all the sections (the section along 71°10′N excluded) being negative. The thermal conditions of the waters in the northern branch of the Irminger Current and on the sections north of 72°50′N approached normal.

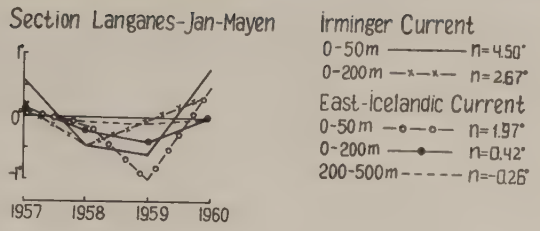


Figure 25. Anomalies of the water temperature on the section between Cape Langanes and Jan Mayen.

In June 1960, the routine survey of the Norwegian and Greenland Seas was carried out giving data for evaluating the thermal conditions.

In the Faroe-Shetland Channel the temperatures in 1960 were at the level of the warm year of 1954. The temperatures in the upper layer appeared to be 1°—1.5° C higher than in 1954.

On the section between Cape Langanes and Jan Mayen in the areas of the warm Irminger Current the temperatures in the 0—50 m layer were 0.8° C above normal and those in the 0—200 m layer were 0.3° C above normal. In the waters of the East Icelandic Current the intense summer heating of the 0—50 m layer resulted in anomalies of about +0.5° C. In all other layers the water temperature was not above normal (Fig. 25).

A considerable heating of the upper layers in the southern part of the Norwegian Sea and a wide spreading of the thermal wave to the north-west was clearly shown in the position of the 8° C isotherm in July during a number of years. In 1960 this isotherm had moved 100—140 miles northwestwards as compared with other years (Fig. 26).

On the section along 74°30′N (Fig. 27) in the eastern branch of the Norwegian Current positive

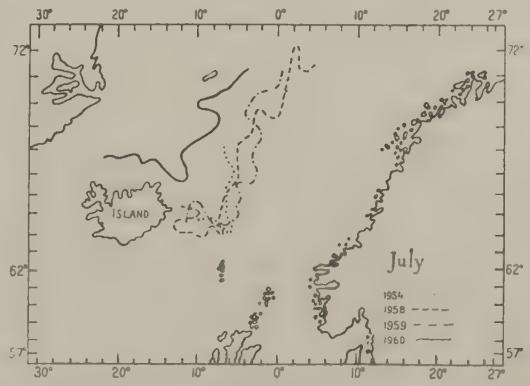


Figure 26. The position of the 8° C isotherm at the surface in July 1960.

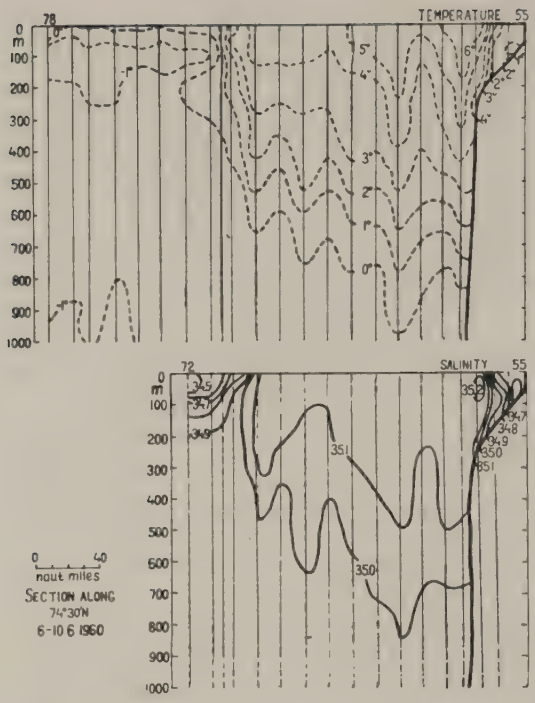


Figure 27. Temperature and salinity on the section along 74°30′N in June 1960.

anomalies of about 0.3°—0.4°C were also observed. The temperature conditions on the remainder of the section were about normal, whereas in 1959 they were considerably below normal.

On the sections along 76°30′N and 78°00′N the temperatures of the West Spitsbergen Current increased by 0.6°—0.8°C.

Thus the thermal level of the water masses in the Norwegian and Greenland Seas in the summer of 1960 exceeded on the whole the level of almost all the years during which the observations were carried out. The most characteristic feature of the hydrographic conditions of the Norwegian and Greenland Seas in 1960 was the abnormally increased heat content of the waters of the western branch of the Norwegian Current, accompanied by almost normal thermal conditions in the eastern branch.

A. P. Alekseev, B. V. Istoshin,
L. R. Shmarina

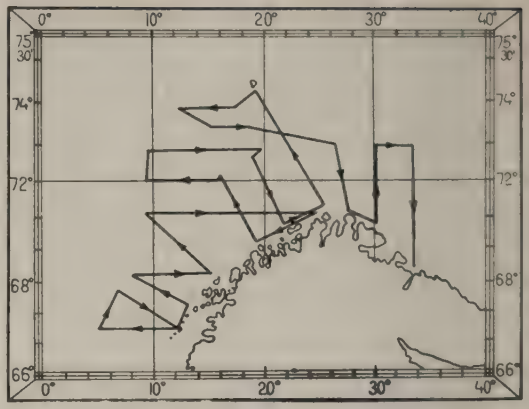


Figure 28. Scheme of the hydrographic sections worked by R. V. "Tunetz" in April/May 1960.

Hydrographic Conditions in the Norwegian Current and the North Cape Current in the Spring of 1960

(Figures 28–29; Table 3)

In 1960 investigations on the hydrographic conditions on the spawning grounds of the Atlantic cod were carried out during the 15th cruise of the R. V. "Tunetz". The observations covered an area extending from 67°30′N to 73°50′N and from 05°00′E to 33°30′E; for the sake of continuity the observations were conducted along the same standard sections (Fig. 28) as in 1959.

The data given in Table 3 shows that the water temperature in the eastern branch of the Norwegian Current from 67°30′ to 70°00′N was higher in 1960 than in 1959, while in position 70°00′—73°00′N it was at the same level as in 1959. The temperature of the North Cape Current appeared to be much higher than it was in 1959, and in May 1960 it was at the level of warm years. For instance, in May 1960 the temperature on the sections between North Cape and Bear Island and along the Kola Meridian was respectively 0.60° and 0.40°C above normal, that is 0.21° and 0.25°C higher than in 1959.

In June 1960, the mean water temperature of the 0—200 m layer in the West Spitsbergen Current (section along 74°30′N) was 0.15°C above normal and that of the North Cape Current was 0.66°C above normal. In July the water temperature of both the northern branches of the North Cape Current and the Murman Current (Kola Meridian) exceeded the normal by 0.50°C. The chart of temperature isanomalies (Fig. 29) shows the temperature conditions in the upper layers of the sea.

Table 3. Mean temperatures in the 0—200 m layer on the standard sections in 1959 and 1960

	1959			1960		
No. of section	Position	Date	Temp. (°C)	Date	Temp. (°C)	Deviation
7—C	67°30′N, 5°—8°30′E	24.—25. Apr.	6.38	27.—28. Apr.	7.12	+ 0.74
8—C	69°20′N, 11°—14°55′E	29.—30. Apr.	6.20	2. May	6.44	+ 0.24
9—C	71°10′N, 12°—14°50′E	3. May	6.34	5. May	6.26	— 0.08
10—C	72°50′N, 11°30′—15°00′E	12. May	5.61	11.—12. May	5.63	+ 0.02
1	69°30′N, 15°36′E—70°06′N, 13°40′E	1. May	6.15	3.—4. May	6.96	+ 0.81
2	70°24′N, 19°04′E—72°10′N, 16°20′E	5.—6. May	6.11	8.—10. May	6.34	+ 0.23
3	71°33′N, 25°02′E—73°35′N, 20°46′E	17.—18. May	4.83	15.—16. May	5.04	+ 0.21
6	69°30′N, 33°50′E—72°30′N, 33°30′E	22.—23. May	3.59	23.—24. May	3.84	+ 0.25

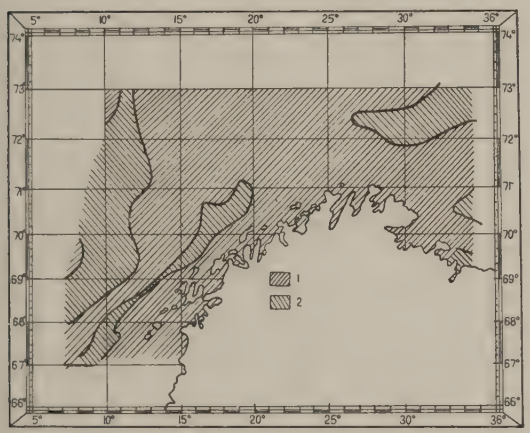


Figure 29. Isanomalies of the water temperature in the 0—50 m layer in April/May 1960.
1 = the area of increased temperature in comparison with 1959. 2 = the area of lower temperature in comparison with 1959.

Although the heat content of the waters of the area investigated increased in 1960 there were some regions where the temperature in the 0—50 m layer was lower than in 1959.

A temperature distribution such as the charts of dynamic topography reveal is the result of the inhomogeneous structure of the current; the drop in temperature occurs in the western part of the cyclonic inter-stream eddies. The total strength of the current results in an increased rate of cyclonic circulation in the eddies causing a greater exchange of water between the deeper and upper layers, which in turn causes a decrease in temperature in these regions.

The high salinity of the water masses indicates an increased influx of Atlantic waters in 1960, the corresponding isohalines having advanced 100 naut. miles further than in 1959.

In 1960 the annual mean temperature in the 0—200 m layer along the Kola Meridian corresponded to that of 1959, whereas the annual mean salinity in 1960 was 0.23‰ higher than that of 1959.

A. G. Kisljakov

Figure 30. Bottom temperature in the North Sea in March/April 1960.

B. Near Northern Seas

Some Results of International Hydrographic Investigations in the North Sea in March/April 1960

(Figures 30–35)

In order to obtain information on the local distribution of herring races, a conjoint investigation programme was set up by ICES in October 1959. An investigation on the distribution pattern of herring in the North Sea was planned for the periods March/April and September/October 1960. The fact that special attention was paid to the presence of marketable fish in relation to their environment during the Conjoint Herring Survey offered an excellent opportunity to examine the hydrographic conditions in the North Sea area.

Considering the complexity of such an enterprise it is only natural that the final results are not yet available. Therefore this contribution presents only some results which can serve as basis, or comparative basis, for fishery biological investigations.

The quasi-synoptical charts are based on measurements performed at 354 stations. The responsibility for the data collected by the institutes of the member states: Denmark, England, Germany, Netherlands, and Scotland, is taken by the respective authors. The compilation of these data, the sketch of the illustrations, and the notes in this brief article are from the last mentioned author, under the auspices of the Chairman of the Herring Committee, B. B. Parrish.

From the early days of systematic oceanographic research it is known that continental influences on heat transformation and water circulation, produce a stronger differentiation in the distribution of hydrographic factors in the vicinity of the continent, where shallow waters and strong tidal currents prevail. The synoptic charts (Figs. 30—32) indicate the conditions at the time of observation. These conditions do not merely result from long-term periodical processes; the influence of weather conditions is of considerable importance.

Furthermore, such unperiodical processes of short duration can affect the entire water column in the shallower parts of the North Sea.

Heat transformation between the ocean surface and the air was of minor importance only during the time of investigation. That Figs. 30–32 reveal noticeable differences in the distribution of temperature, salinity, and density near the bottom is mainly due to horizontal distribution processes. According to studies made by G. Wurlitzer, board meteorologist of F. F. S. "Anton Dohrn", from late in February to the beginning of April 1960, prevailing winds from the ESE exerted their influence on the surface waters. This more in the southern and eastern North Sea than in the northern and western. Since this anomalous wind is a real "additional wind" it must be investigated to what extent it has influenced the hydrographical conditions at the time. Meteorological effects have obviously been the cause of the considerable advance of continental coastal water and Baltic water towards the western and NNW section of the North Sea. Between 56°30′ and 58°40′N this water moved to 2°E, dividing the Atlantic water body into two tongues.

The low temperatures over the Dogger Bank should be interpreted as a consequence of the winter cooling of the shallow water over the bank.

The figure illustrating the salinity pattern (Fig. 31) indicates the extension of water masses of different origin even better than the temperature chart. Within the western and eastern section of the central North Sea the Atlantic Channel water and the North Atlantic water ($> 35.0‰$) intermingle with the North Sea water (34.0 to 35.0‰). The continental coastal water and the Baltic water ($< 34.0‰$) are affected by admixture of fresh water coming from the continent. The narrow band of the English coastal water was not included in the observations.

The tidal movements of the North Sea are superimposed by water motions caused by density differences, fluctuating winds, and variations in atmospheric pressure. Such residual currents, which can only be detected by eliminating the tidal currents, are not only of substantial importance in the transport of fish fry, but also in distribution and migration of commercial fish. Deductions may be drawn concerning the current pattern from the course of the isotherms, isohalines, and isodenses. The density pattern (Fig. 32) gives evidence of large eddies north of the Dogger Bank, at the Scottish coast, and in the German Bight. The Atlantic Channel water, moving in as one body, breaks up in several small eddies, recognizable at the south-eastern edge of the Dogger Bank.

Figure 31. Bottom salinity in the North Sea in March/April 1960.

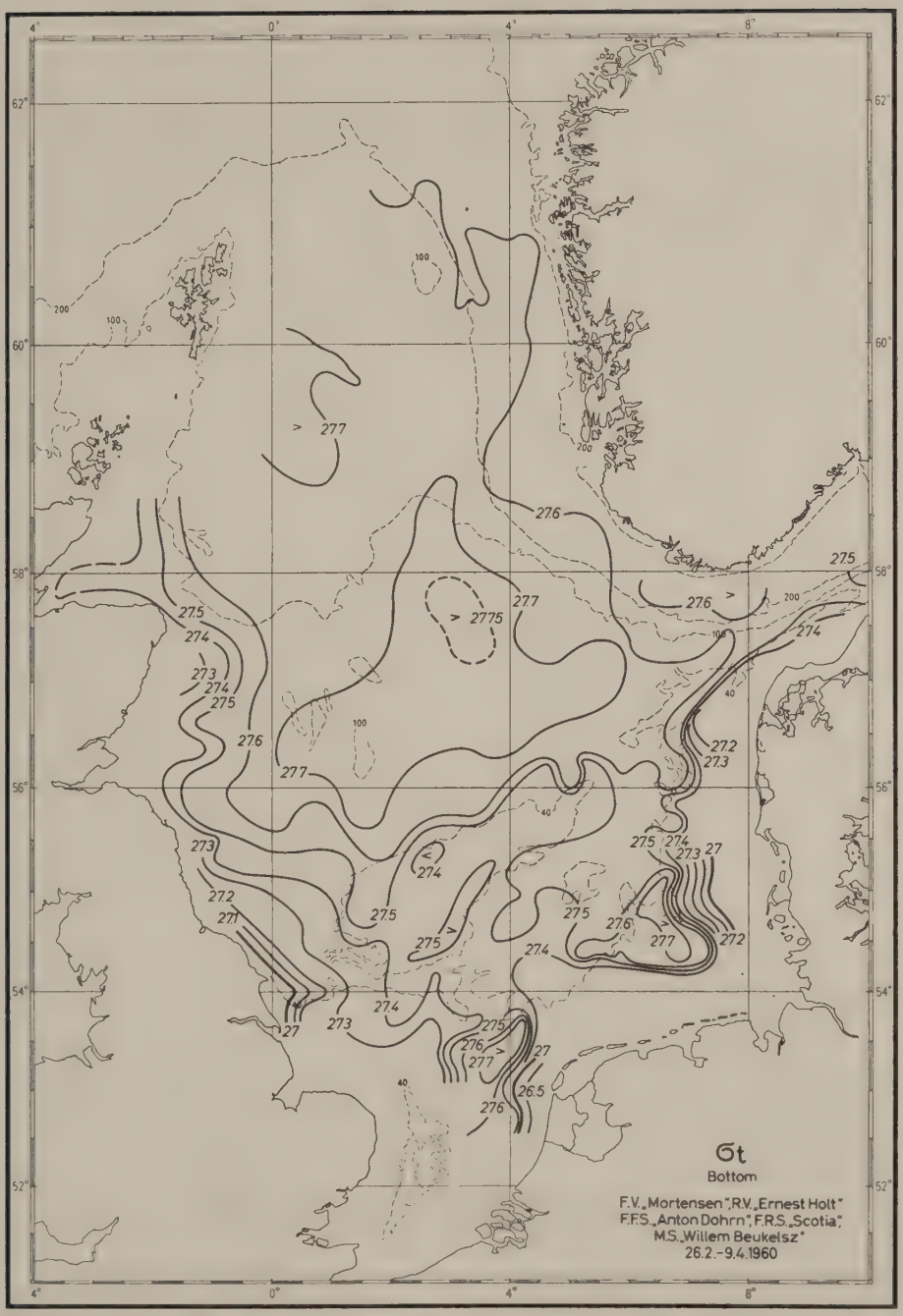


Figure 32. Bottom density in the North Sea in March/April 1960.

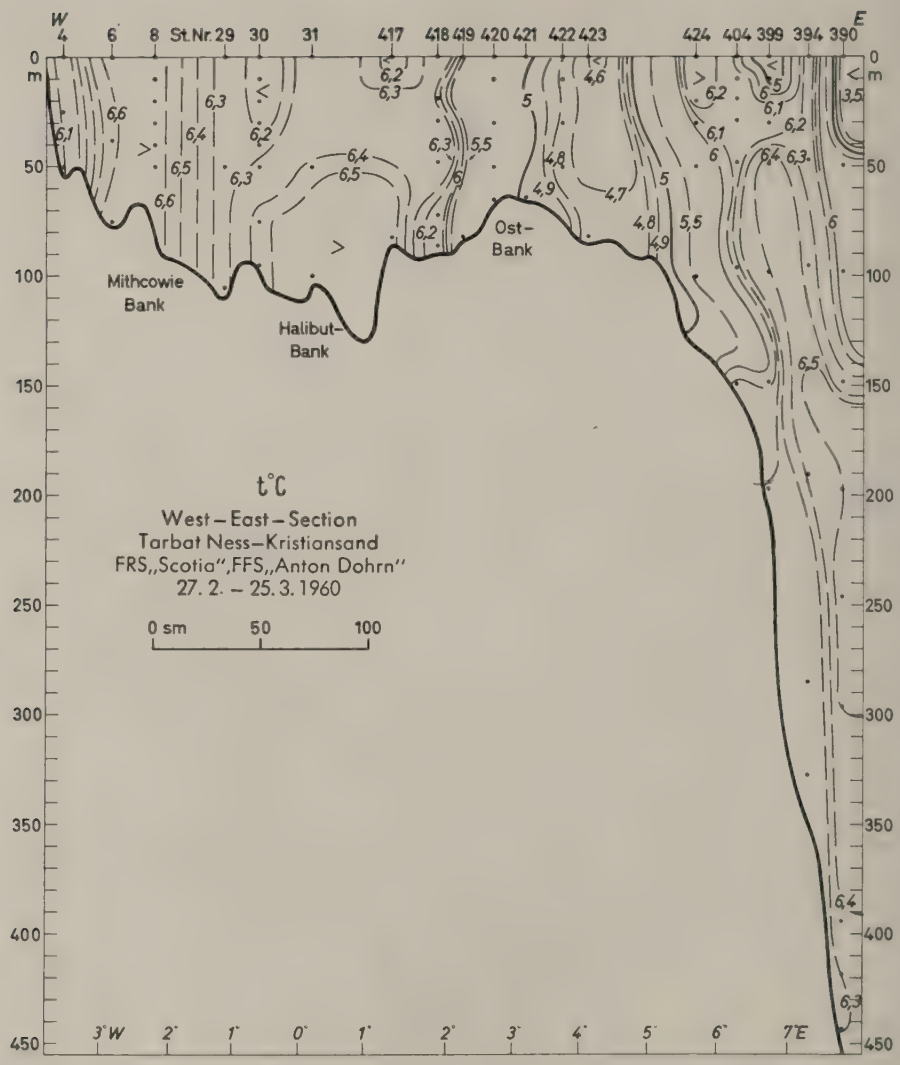


Figure 33. Temperature on a west-east section between Tarbat Ness and Kristiansand. 27. February to 25. March 1960.

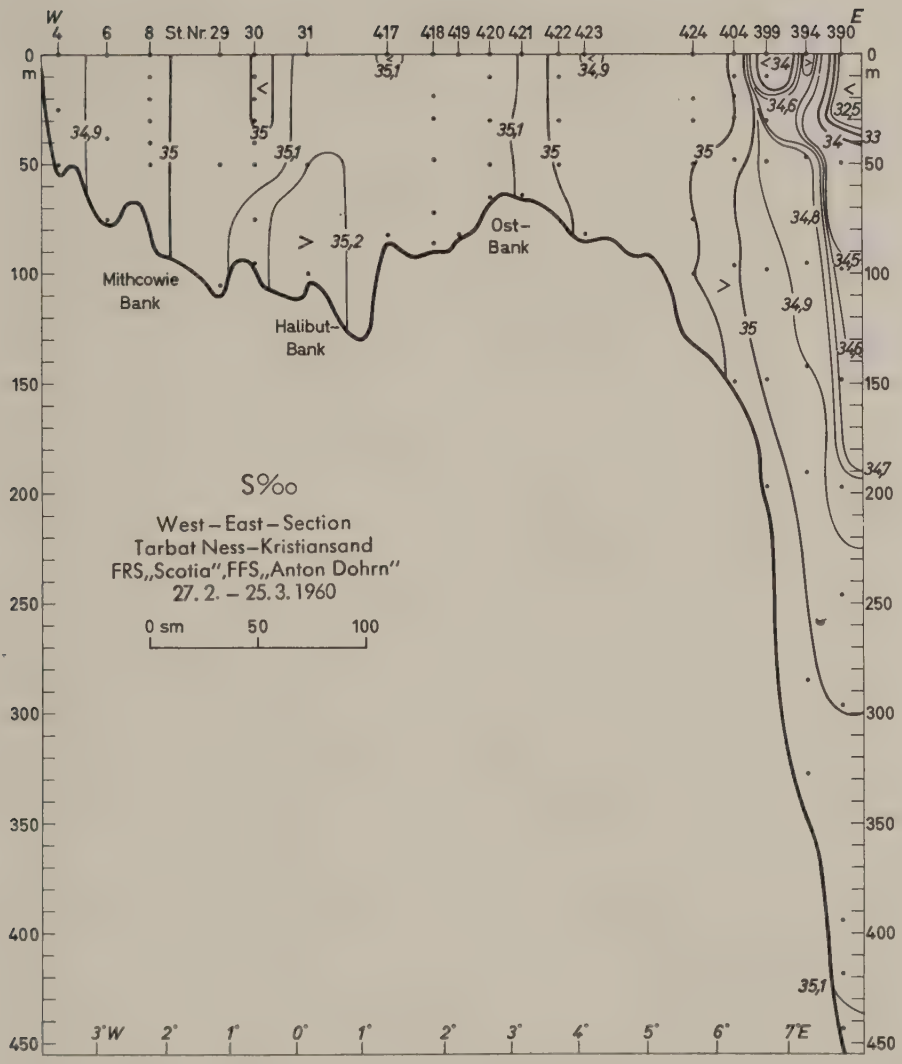


Figure 34. Salinity on a west-east section between Tarbat Ness and Kristiansand. 27. February to 25. March 1960.

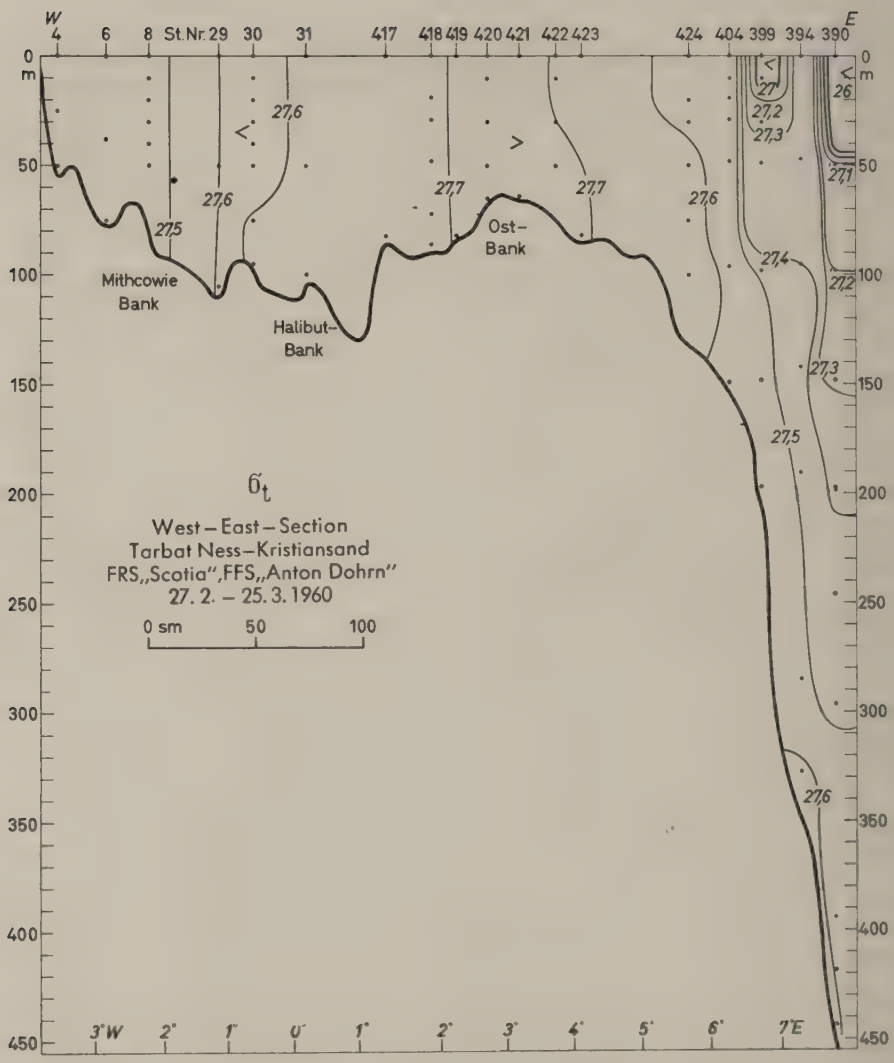


Figure 35. Density on a west-east section between Tarbat Ness and Kristiansand. 27. February to 25. March 1960.

As revealed by Figures 30—32 the west-east section, cutting the water bodies, gives an insight into the vertical structure of temperature, salinity, and density (Figs. 33—35). The almost straight course commences with station No. 24 of F.R.S. "Scotia" (position: 57°54′N, 3°32′W) and is terminated with station No. 390 of F. F. S. "Anton Dohrn" (position: 57°44′N, 7°44′E).

Through the winter cooling, which reaches its maximum in February, the convection movements extend down to the bottom in by far the largest part of the North Sea, except in the region of the Norwegian Trough. Here the surface layers are "freshened" to such an extent by the water from the Baltic Sea that the vertical convection does not reach the bottom. This region owes its outstanding hydrographical position to the Baltic Current which transports cold Baltic low salinity water into the North Sea. At the end of March the Baltic Current produces a stable pattern of the water layers. The density differences are then so great that a discontinuity layer develops at a depth of 20—50 m where plankton organisms accumulate. The two water bodies, lying side by side, are at this time divided by a narrow zone. Fish congregate along this zone (western edge of the Baltic Current) with its steep gradients. This was observed in the three sections west of station No. 404. The upper edge of the North Atlantic water lies in the Skagerak at a depth of 300 m.

This brief glance at the hydrographical phenomena and their consequences was only possible through a close co-operation on international basis. Whether and to what extent the hydrographical conditions observed reflected the normal pattern cannot be decided until all the observations are duly evaluated.

R. E. Craig, A. J. Lee, K. Popp Madsen,
J. J. Zijlstra, E. H. Rogalla

International Hydrographic Investigations in the North Sea in September/October 1960

(Figures 36–37)

Participating in the enterprise of the Conjoint Herring Survey between 26. August and 13. October 1960 were the research vessels "Dana", "Sir Lancelot", "Anton Dohrn", "Willem Beukelsz", "Clupea", and "Scotia". The evaluation of the hydrographic data is presented on p. 27 of the contribution above. Owing to the fact that the working-up of the extensive data is still in its initial stage, the present contribution gives only an illustration of the temperature and salinity distributions in the water layers near the bottom. It is generally known that these two hydrographical factors affect the concentrations of the fish and are thus of interest to fishery biology studies.

The hydrographic operations of the research vessels altogether comprise 488 stations. The synoptical charts (Figs. 36 and 37) are both based upon observations made at these stations. The salinity distribution chart indicates the presence of four water masses of different origin. As compared with the period of 26. February to 9. April 1960, only insignificant changes in the distribution of the North Sea waters took place within the south-western North Sea. However, in the eastern part of the central North Sea (between 2° and 5°E) the water tongue which moved into the North Atlantic water had disappeared. The distribution pattern of the temperature is the product of the vertical heat transport, the guiding principles of which are sufficiently known. As compared with the previous year the two cores of cold bottom water and the small cold-water island of the central and northern North Sea reveal temperatures which are lower by about 0.5°C.

K. P. Andersen, R. E. Craig, A. J. Lee,
J. A. van Duijnen Montijn, E. H. Rogalla

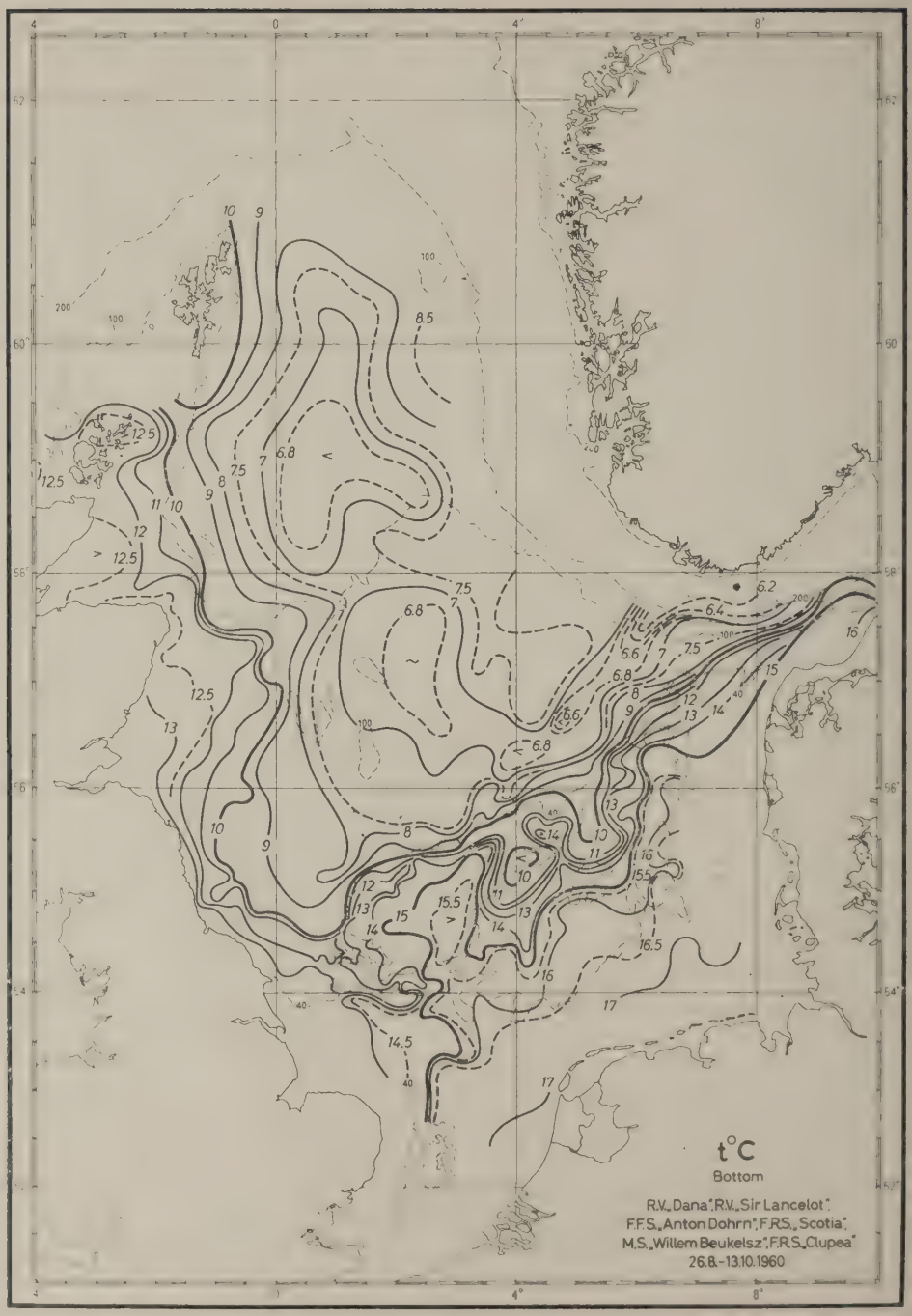


Figure 36. Bottom temperature in the North Sea in September/October 1960.

Figure 37. Bottom salinity in the North Sea in September/October 1960.

Figure 38. Station positions of "Anton Dohrn", "Sir Lancelot", and "Platessa", 4.—22. January 1960.

Hydrographic Conditions in the Southern North Sea and the English Channel in January 1960

(Figures 38–42)

An international working programme has been approved by the ICES in order to trace the destiny of herring fry from the time they are hatching on the spawning grounds until they reach the young-fish grounds, and further up to their maturation. The cruise of F. F. S. "Anton Dohrn" from 6. to 20. January 1960 represents the German contribution towards this programme, and below a brief survey of the hydrographic conditions is given. The author is indebted to A. J. Lee, Lowestoft, for providing hydrographic data from the research vessels "Sir Lancelot" and "Platessa". Valuable supplements were thus provided for the cartographical representation of temperature, salinity, and density distribution (Figs. 39—42) for the period in

Figure 39. Surface temperatures in the southern North Sea and the English Channel, 4.—15. January 1960.

question. Figure 38 shows the stations where the hydrographic measurements were made.

After the herring larvae hatch from the eggs which cling to the bottom they are carried from the spawning grounds by the currents. In case the only water movements in the area would be those of the tides, all particles would at the end of one or more tides return to their original position. Due to influx of fresh water from the continent density differences occur, and wind and air pressure changes are further influencing the water masses. The residual currents aroused hereby are superimposed on the tidal movements and thus on the transport of the fish larvae. From the distribution of the hydrographical features (Figs. 39—42) it might be possible to determine the route of transport of the planktonic fish fry. Figure 42 shows the rather confused current system developing after the Atlantic Channel water has passed through the Straits of Dover. The tongue of relatively warm, high-salinity (>35.0‰) water from the English Channel indicates a water movement towards the German

Figure 40. Surface temperatures in the southern North Sea and the English Channel, 16.– 19. January 1960.

Figure 41. Surface salinity in the southern North Sea and the English Channel, 4.—20. January 1960.

Figure 42. Surface density in the southern North Sea and the English Channel, 4.—20. January 1960.

Bight. Figure 41 shows the spread of North Sea water, continental coastal water, and of the English coastal water in the Thames Estuary ($< 34.0^0/_{00}$).

Owing to the fact that continuous north-eastern winds lead to rapid changes in the temperature pattern (Fig. 39), the observations (Fig. 40) made after 15. January could not be used in compiling a synoptic chart.

During the winter the water masses of the entire English Channel and the southern North Sea are homothermic. In the Bay of Biscay the salinity values are constant down to several hundred metres and they remain so when the waters flow over the continental shelf, the homogeneous character of the waters of the English Channel is thus easily understood. When exceptional conditions in inshore waters are excluded there is no layering which could prevent the complete mixing of the whole water column.

In this contribution only the hydrographical conditions at the time of observation are presented, and they may be of importance for a better understanding of fishery biological phenomena.

E. H. Rogalla

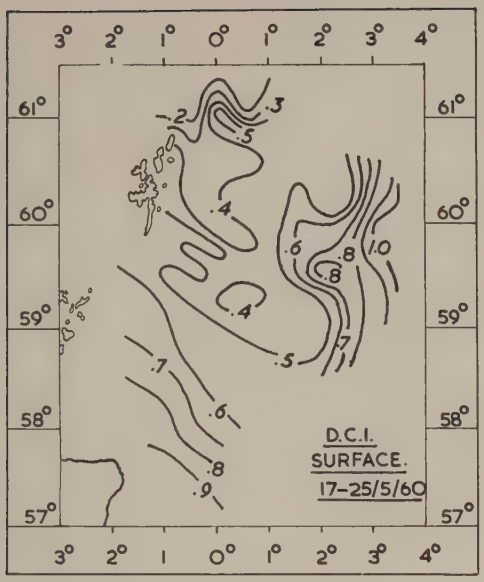


Figure 43.

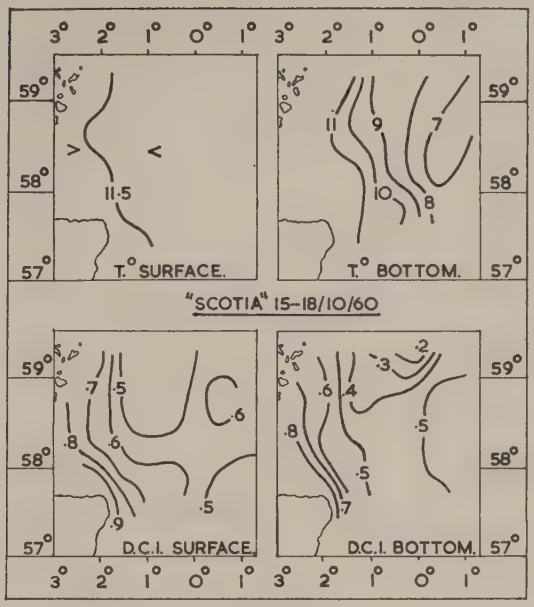


Figure 44.

Hydrographic Surveys of the Northern North Sea 1960

(Figures 43–47)

1960 saw the first series of international surveys under the auspices of the Herring Committee. Two such surveys were made in March and September covering the major part of the North Sea. Scottish results are included in the charts provided by E. Rogalla for this volume (see Figs. 30—35).

Other Scottish results are shown in Figures 43 to 47, salinity being expressed as D. C. I. (Craig, this journal Vol. X, pp. 87—89). The results may be summarized as follows.

Salinity: Surface values are low throughout the year, exceptionally so in May. Bottom values are low in June, but a considerable inflow takes place later so that a well marked intrusion exists in October (Fig. 44). Subsequently this intrusion is destroyed by vertical mixing.

Upper water movements as shown by drift indicators have been low — circulation being typically of the order of 1 mile per day only.

Temperature: Both at surface and at the bottom, temperature has been 1° to 1.5°C above average. The general body of water started the year above average temperature, following on the high values of 1959. During the year it would appear that the evaporative cooling has been minimal.

R. E. Craig

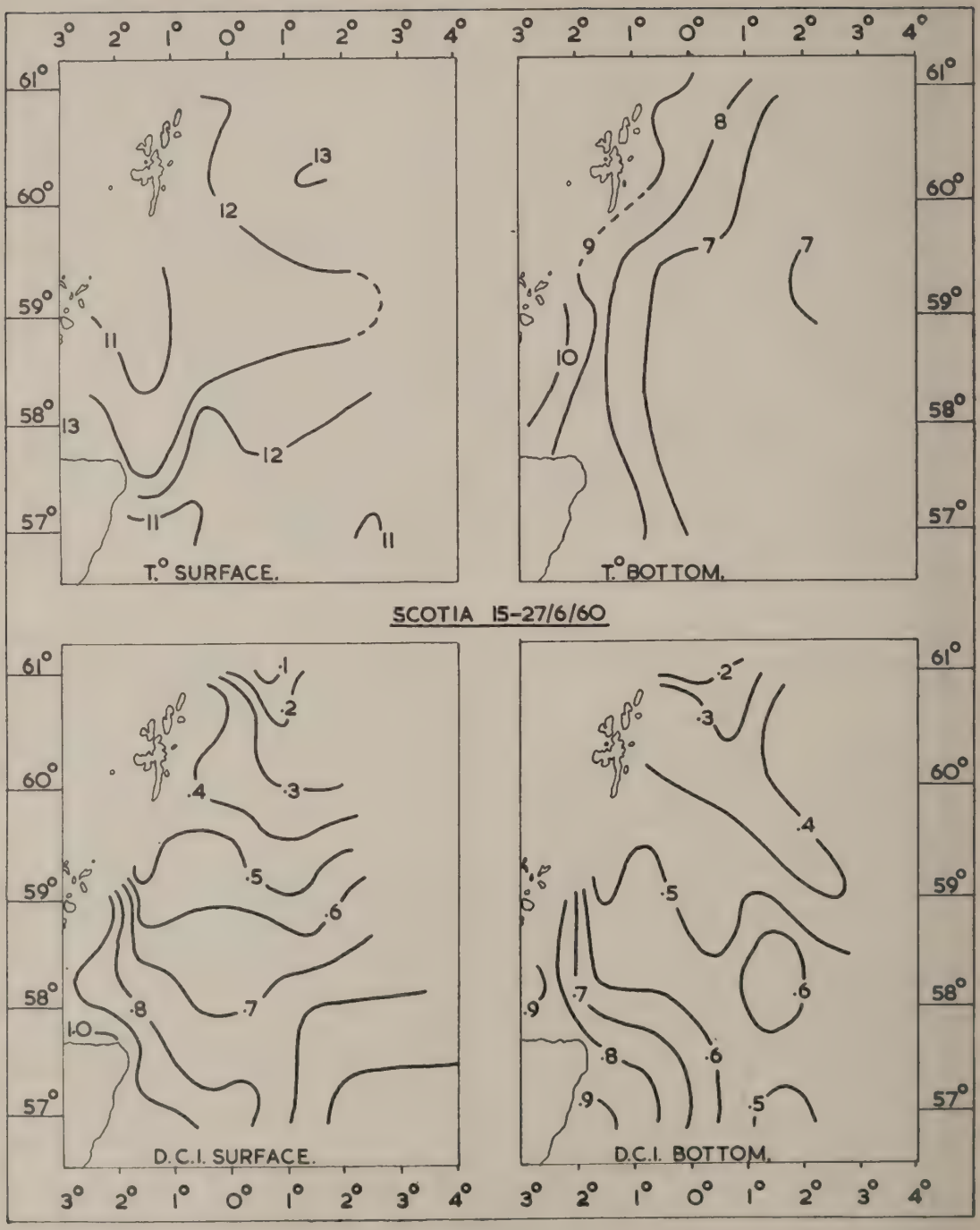
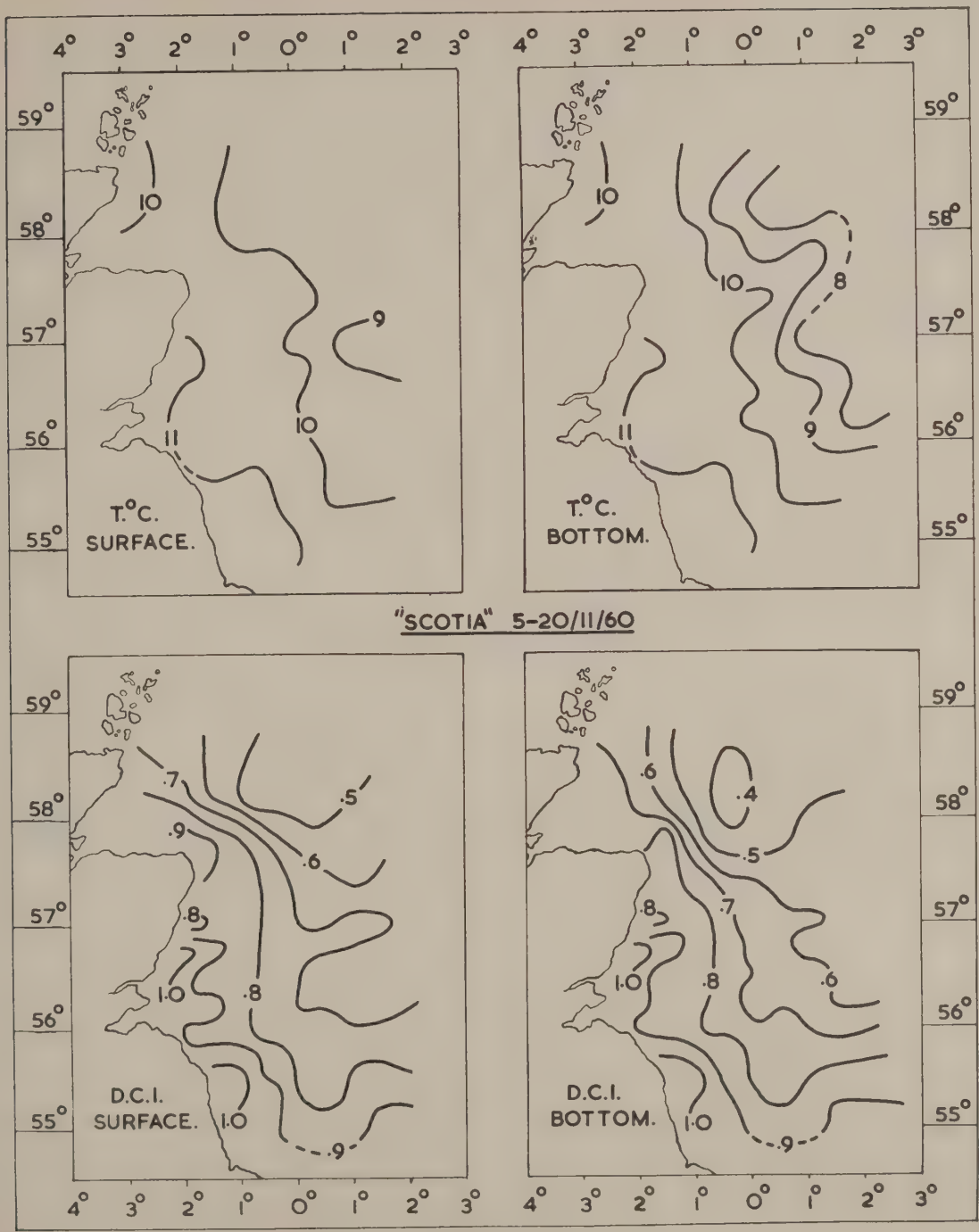


Figure 45.


4° 3° 2° 1° 0° 1° 2° 3°
59° 58° 57° 56° 55°
10
9
10
11
T.°C.
SURFACE.
10
10
8
9
11
T.°C.
BOTTOM.
"SCOTIA" 5-20/11/60
.7
.5
.9
.6
.8
1.0
.8
1.0
.9
D.C.I.
SURFACE.
.6
.4
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1.0
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.6
1.0
.9
D.C.I.
BOTTOM.

Figure 46.

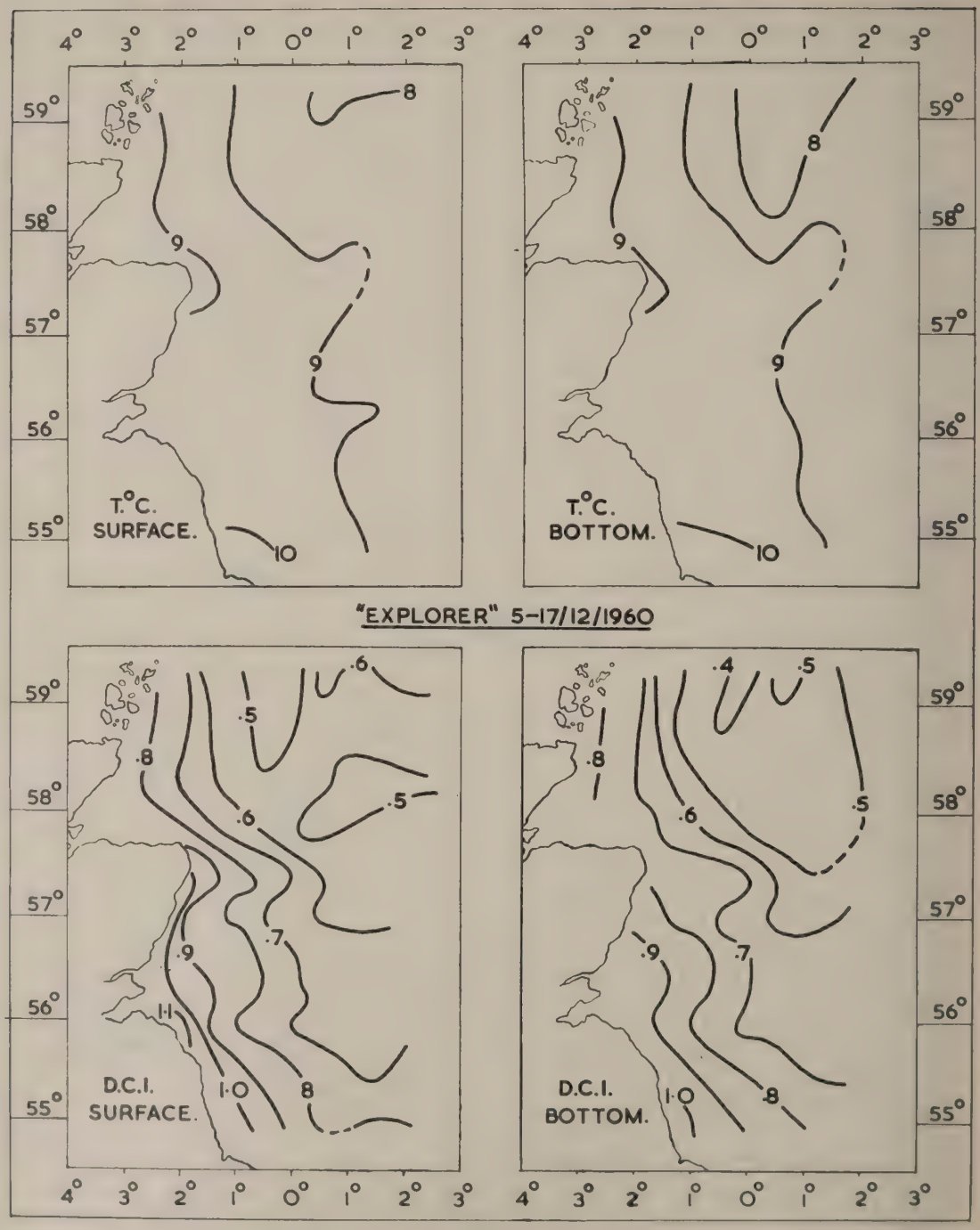

"EXPLORER" 5–17/12/1960
T.°C. SURFACE.
T.°C. BOTTOM.
D.C.I. SURFACE.
D.C.I. BOTTOM.
4° 3° 2° 1° 0° 1° 2° 3°
59° 58° 57° 56° 55°

Figure 47.

Hydrographical Observations in the North Sea in July 1960

(Figures 48–51)

In the period from 7. July to 1. August the fishery research vessel "Anton Dohrn" carried out a large-scale cruise to investigate the distribution of fish in the North Sea. This cruise also supplied information on hydrographic conditions. As the working-up of the hydrographic data has not yet been completed, this contribution presents only some results which might be of interest for fishery biology studies.

The hydrographic investigations (9.—31. July) comprised 182 stations where serial and bathythermographical measurements were performed. Figures 48 and 49 show the distribution of temperature and salinity near the bottom. In Figures 50 and 51 the vertical stratification of the water over the period 13.—29. July is surveyed. The course of the profile is shown in Figures 48 and 49. The salinity distribution reveals the following water masses:—

North Atlantic water of more than 35.0‰ salinity;
North Sea water of salinity between 34.0‰ and 35.0‰;
Baltic water and continental coastal water of salinity below 34.0‰.

Every summer more or less extensive islands of cold bottom water can be found in the central and northern North Sea (Rogalla, this journal, Vol. XVI, p. 35). Their positions and temperatures, particularly those below 6.5°C, appear to have considerable influence upon the concentration of fish (Dietrich, Sahrhage, and Schubert, 1960).

As compared with 1959 the temperatures of the North Atlantic water, flowing tongue-like along the western edge of the Norwegian Trough towards the North Sea, had dropped by more than 1°C. Over the Dogger Bank the water masses were also some 2.5° colder in July 1960.

The zone of cold bottom water south-east of the Dogger Bank was on the contrary about 1°C warmer than in 1959. It included, however, a small cold-water island with temperatures below 7.5°C (1959: < 8°C), east of Tail End.

The patterns of the thermohaline layers as given in Figures 50 and 51 are the products of the heat transformation at the surface, the wind-produced turbulence, and the local varying velocities of the tidal streams.

In the northern North Sea the features of the bottom layer lying under a medium layer of over 30 m thickness, demonstrates its Atlantic character.

The cold bottom water of the central North Sea is not stratified. It is only superimposed by a medium layer of about 20 m thickness. The haline stratification ends over the Great Fisher Bank, and the thermic statification ends also south of the Dogger Bank. Here the cold residual water body is only superimposed by a thin layer of medium water. In the southern North Sea no stratification was found throughout the year.

E. H. Rogalla

References

Dietrich, G., Sahrhage, D., & Schubert, K., 1959. "Locating fish concentrations by thermometric methods". Modern Fishing Gear of the World, pp. 453—61. London.

Rogalla, E. H., & Sahrhage. D., 1960. "Heringsvorkommen und hydrographische Situation in der Nordsee im Juli 1959 und 1960". Inform. Fischwirtsch., 7 (5/6).

Figure 48. Bottom temperature in the North Sea, July 1960.

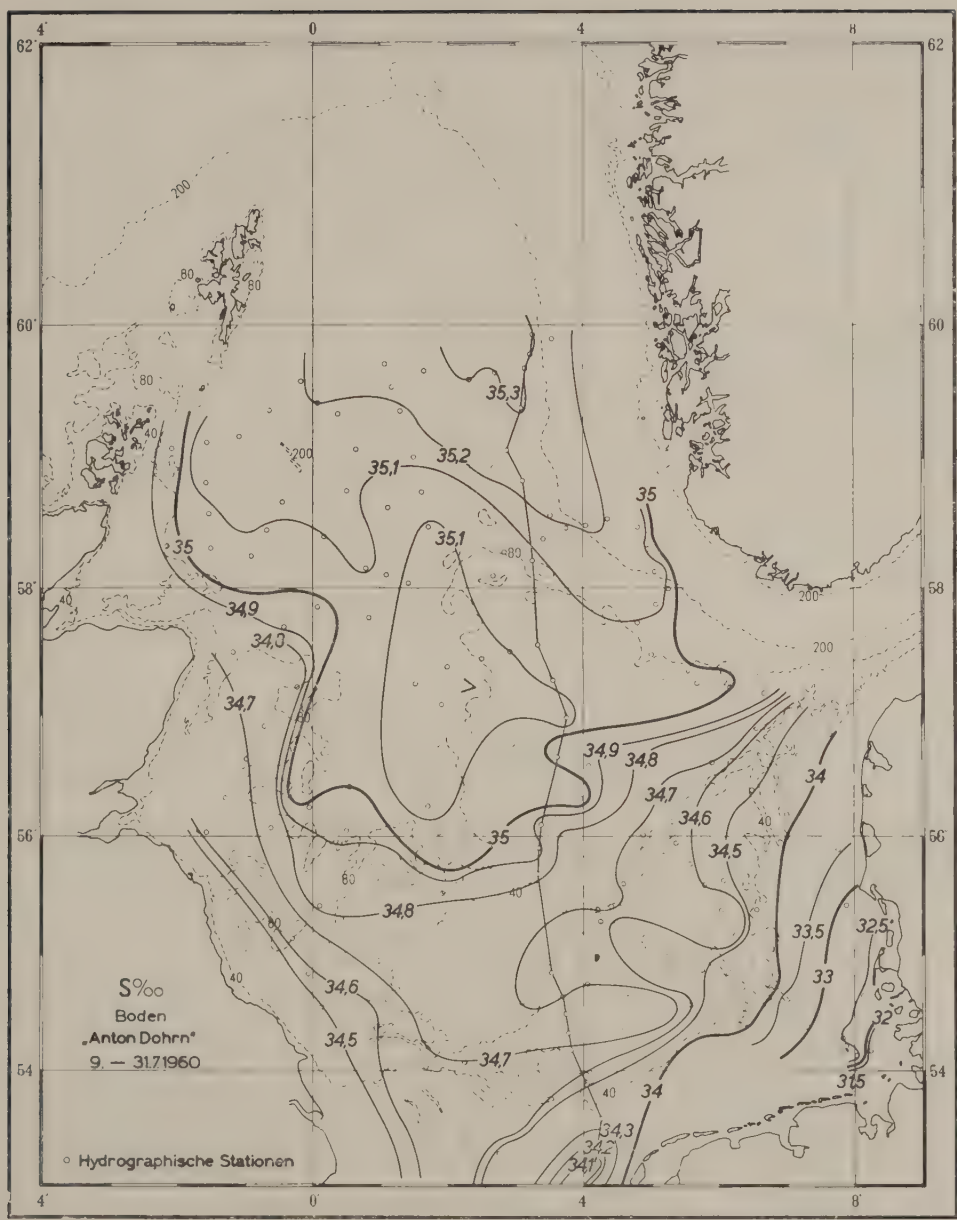
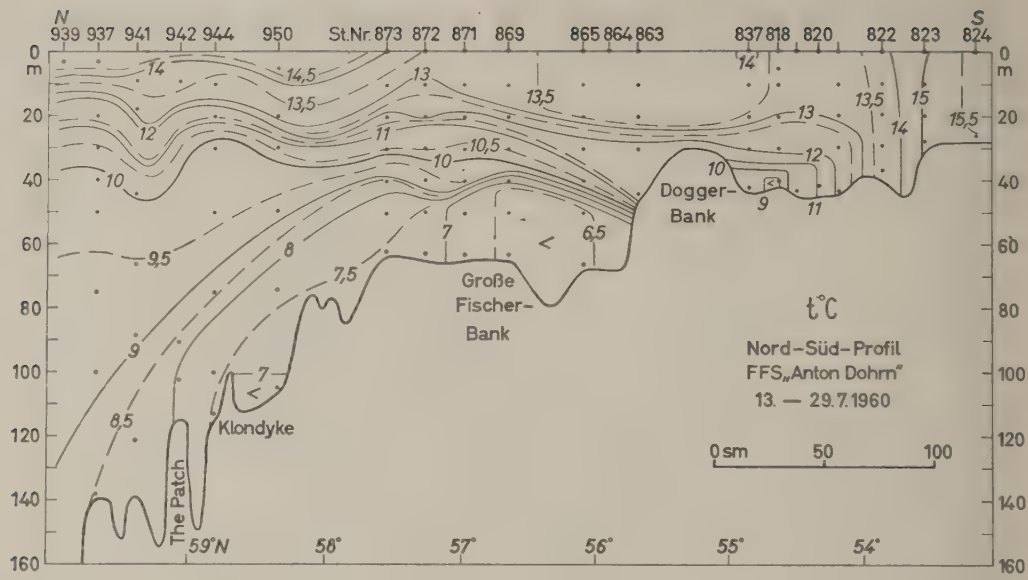
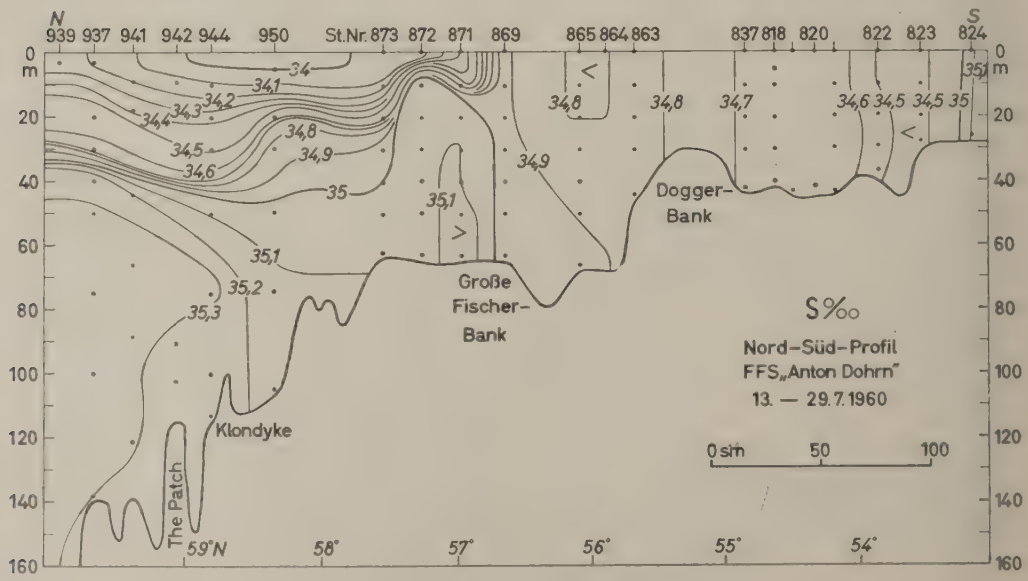


Figure 49. Bottom salinity in the North Sea, July 1960





Figures 50 and 51. Temperature and salinity on a north-south section. The course of the section is given in Figures 48 and 49. Observation period, 13.—29. July 1960.

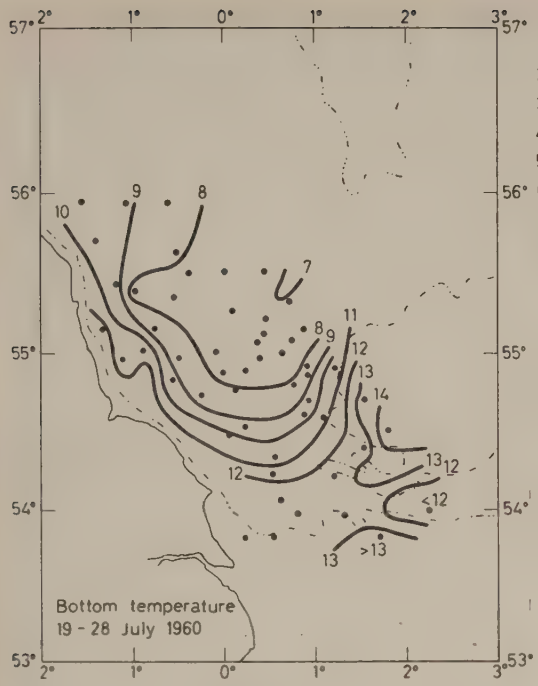


Figure 52.

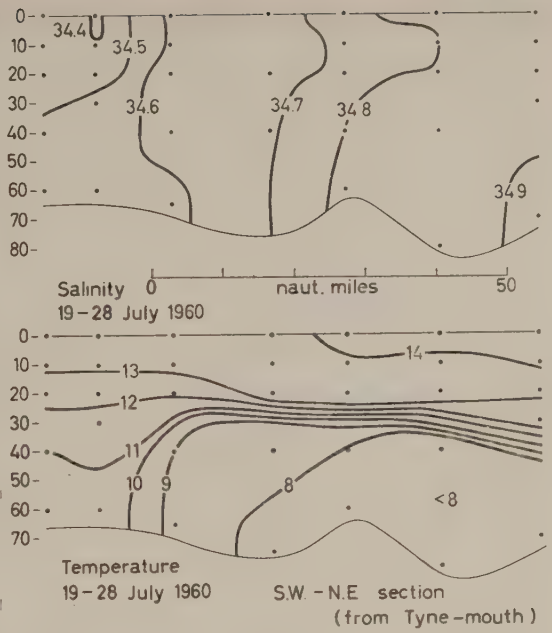


Figure 54.

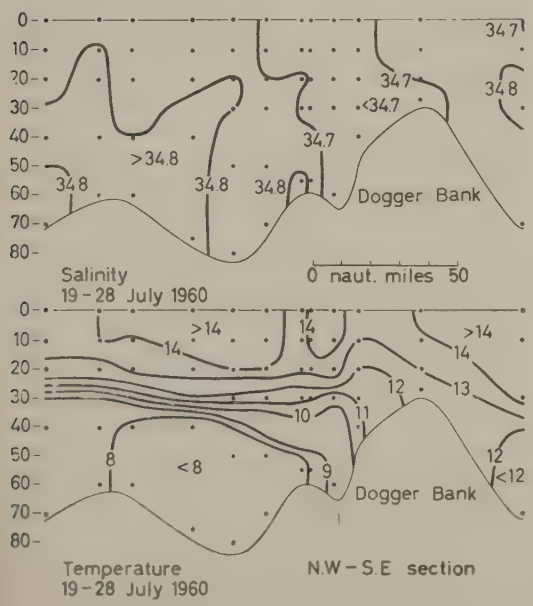


Figure 53.

Hydrographic Conditions in the Western Part of the Central North Sea in July 1960

(Figures 52–55)

In the period 19. to 28. July, 54 hydrographic stations were worked in the North Sea by the Netherlands fisheries research vessel "Willem Beukelsz". The results are shown in Figures 52—55.

The surface observations indicate a situation which did not differ considerably from the climatological mean for this region. Compared with the same period in 1959 the temperature differences were greater at the bottom; bottom temperatures along the English coast were higher, and northwest of the Dogger Bank they were lower than in the preceding year. The salinity of the bottom water showed higher values over the Dogger Bank, as compared with 1959, and lower values in the deeper areas to the north and west.

Two vertical sections are presented, one running NW-SE, parallel to the English coast, and one from the coast in the neighbourhood of the River Tyne towards the north-east. The temperature sections, based on thermometer readings and BT

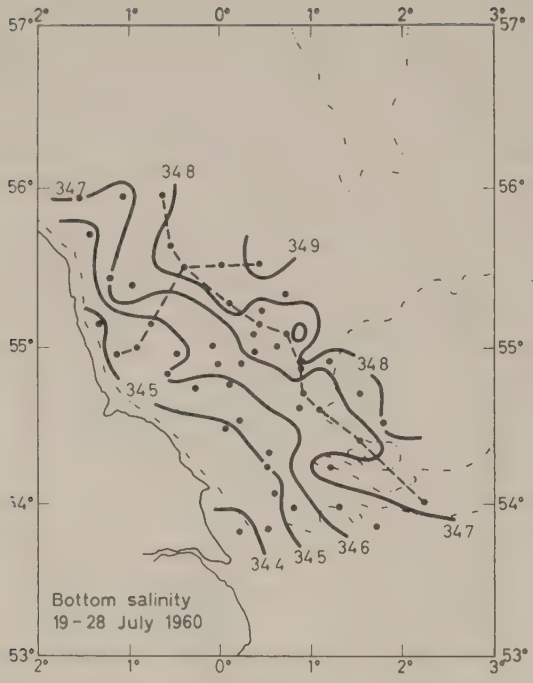


Figure 55.

recordings, show a decreasing trend towards the coastal regions and over the shallower parts of the Dogger Bank.

L. Otto, K. H. Postuma

Means and Anomalies of Temperature and Salinity on the Hamburg-Hull Route in 1960

(Tables 4–5)

German commercial vessels continued to make observations in the surface layers for the German Hydrographic Institute in 1960. Again, routine observations were made from ships *en route* at seven positions[1]). Temperature and salinity observations collected throughout 1960 have been expressed, as far as possible, as monthly means. In addition, monthly anomalies in reference to the periods 1902 to 1928[2]) and 1953 to 1960 have been computed for 1960 (see Tables 4 and 5). These deviations from the long-term means give a survey over the monthly variation of the heat and salt budgets in the surface water of the southern North Sea. The monthly deviations of the temperature means show that the periods January/March, May/June, August/October, and December were abnormally warm. On the other hand, the months of July and November were abnormally cold. April only was about normal.

In connection with the monthly deviations of the temperature means, the average salinity in the southern North Sea was abnormally high, almost throughout the year. The hydrographic situation reveals low salinity from October to November only.

These monthly deviations from long-term means may also be of importance in connection with climatological fluctuations and fishery problems in the southern North Sea, this especially in the German Bight.

The weather situation in the year 1960 differed completely from that of 1959. The meridional circulation of the atmosphere over central Europe was followed by a zonal circulation in the second half of the year. The most characteristic feature was that warm maritime air masses overflowed north-western and central Europe. The air over Europe was abnormally warm almost throughout the year, for the deviations from the annual means of air temperature were positive at all observation stations. In connection with this mild weather a precipitation deficit[3]) prevailed in the first half of the year, and in several months of the second half. During July only there was a change in the European circulation of the atmosphere; cold maritime air masses flooded the continent. Therefore this month was cold, and also wet.

These are the reasons why the surface temperatures in the entire southern North Sea were abnormally high in several months of the year 1960, and abnormally cold in July. The high salinity of the surface water is due to a stronger influx of Atlantic water and to the continuous precipitation deficit in north-western Europe.

E. Goedecke

[1]) Ann. Biol., **16** (1959): 46—50. 1961.

[2]) Bureau du Conseil: Atlas de température et salinité de l'eau de surface de la Mer du Nord et de la Manche. Copenhague, 1933.

[3]) Deutscher Wetterdienst: (a) Monatliche Witterungsberichte, 8. Jahrg.; (b) Die Großwetterlagen Mitteleuropas, 13. Jahrg. Offenbach a. M., 1960.

Table 4. Mean values and monthly anomalies of surface temperature for 1960 (referred to 1902—1928 and 1953—1960) at fixed positions on the Hamburg—Hull route

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Year	**Position I; 54°09′N, 07°32′E**											
1902/28 .	4.2	3.4	4.2	6.2	9.7	13.2	15.8	16.7	15.5	13.1	9.7	6.7
1953/60 .	5.4	3.9	3.7	6.0	8.8	13.0	15.9	16.9	16.0	14.2	11.1	8.2
1960	5.4	4.7	4.5	5.6	9.1	13.3	15.9	16.6	15.2	14.5	10.6	8.5
ΔT_1	+ 1.2	+ 1.3	+ 0.3	− 0.6	− 0.6	+ 0.1	+ 0.1	− 0.1	− 0.3	+ 1.4	+ 0.9	+ 1.8
ΔT_2	± 0.0	+ 0.8	+ 0.8	− 0.4	+ 0.3	+ 0.3	± 0.0	− 0.3	− 0.8	+ 0.3	− 0.5	+ 0.3
	Position II; 54°18′N, 06°12′E											
1902/28 .	5.3	4.3	4.8	6.2	9.3	12.7	15.4	16.2	15.4	13.4	10.3	7.7
1953/60	5.8	4.3	4.5	5.7	8.4	12.7	15.5	16.6	16.0	14.4	11.2	8.9
1960	6.4	(5.3)	5.0	5.9	8.8	12.3	15.1	16.1	16.2	14.4	11.0	9.5
ΔT_1	+ 1.1	(+ 1.0)	+ 0.2	− 0.3	− 0.5	− 0.4	− 0.3	− 0.1	+ 0.8	+ 1.0	+ 0.7	+ 1.8
ΔT_2	+ 0.6	(+ 1.0)	+ 0.5	+ 0.2	+ 0.4	− 0.4	− 0.4	− 0.5	+ 0.2	± 0.0	− 0.2	+ 0.6
	Position III; 54°19′N, 05°21′E											
1902/28 .	5.7	4.7	5.0	6.3	9.2	12.6	15.2	16.0	15.2	13.4	10.6	8.2
1953/60 .	6.2	4.6	4.8	5.8	8.7	12.7	15.4	16.5	15.9	14.2	11.1	8.9
1960	6.7	(4.8)	5.4	6.7	9.5	12.7	14.6	16.0	16.2	14.1	10.9	9.2
ΔT_1	+ 1.0	(+ 0.1)	+ 0.4	+ 0.4	+ 0.3	+ 0.1	− 0.6	± 0.0	+ 1.0	+ 0.7	+ 0.3	+ 1.0
ΔT_2	+ 0.5	(+ 0.2)	+ 0.6	+ 0.9	+ 0.8	± 0.0	− 0.8	− 0.5	+ 0.3	− 0.1	− 0.2	+ 0.3
	Position IV; 54°10′N, 04°26′E											
1902/28 .	6.0	5.0	5.2	6.4	9.2	12.4	15.1	15.9	15.1	13.4	10.7	8.2
1953/60 .	6.6	5.1	5.0	6.3	8.9	12.9	15.5	16.3	15.8	14.0	11.2	9.2
1960	6.9	5.7	5.4	6.4	9.8	13.5	14.5	16.4	15.2	14.0	10.4	8.9
ΔT_1	+ 0.9	+ 0.7	+ 0.2	± 0.0	+ 0.6	+ 1.1	− 0.6	+ 0.5	+ 0.1	+ 0.6	− 0.3	+ 0.7
ΔT_2	+ 0.3	+ 0.6	+ 0.4	+ 0.1	+ 0.9	+ 0.6	− 1.0	+ 0.1	− 0.6	± 0.0	− 0.8	− 0.3
	Position V; 54°00′N, 03°32′E											
1902/28 .	6.1	5.1	5.3	6.5	9.2	12.0	14.7	15.6	14.8	13.3	10.5	8.2
1953/60 .	6.7	5.1	5.3	6.7	8.8	12.7	15.3	16.2	15.5	13.8	11.0	9.1
1960	7.3	5.8	5.5	6.7	9.5	13.5	14.7	16.3	15.6	13.8	10.2	8.8
ΔT_1	+ 1.2	+ 0.7	+ 0.2	+ 0.2	+ 0.3	+ 1.5	± 0.0	+ 0.7	+ 0.8	+ 0.5	− 0.3	+ 0.6
ΔT_2	+ 0.6	+ 0.7	+ 0.2	± 0.0	+ 0.7	+ 0.8	− 0.6	+ 0.1	+ 0.1	± 0.0	− 0.8	− 0.3
	Position VI; 53°53′N, 02°43′E											
1902/28 .	6.1	5.3	5.4	6.6	9.0	11.7	14.2	15.3	14.6	13.2	10.3	8.0
1953/60 .	6.8	5.2	5.4	6.5	8.7	12.1	14.6	15.5	15.1	13.5	11.0	9.1
1960	7.0	6.4	5.6	6.6	9.3	13.5	14.4	15.8	15.6	13.4	10.1	(8.3)
ΔT_1	+ 0.9	+ 1.1	+ 0.2	± 0.0	+ 0.3	+ 1.8	+ 0.2	+ 0.5	+ 1.0	+ 0.2	− 0.2	(+ 0.3)
ΔT_2	+ 0.2	+ 1.2	+ 0.2	+ 0.1	+ 0.6	+ 1.4	− 0.2	+ 0.3	+ 0.5	− 0.1	− 0.9	(− 0.8)
	Position VII; 53°45′N, 01°54′E											
1902/28 .	6.0	5.2	5.5	6.7	8.8	11.4	13.6	14.8	14.2	12.9	10.1	7.9
1953/60 .	6.4	5.3	5.4	6.6	8.9	11.7	13.9	14.8	14.6	13.1	10.5	8.8
1960	7.2	6.3	5.8	6.9	9.7	12.8	13.8	15.2	15.0	12.6	10.0	(8.1)
ΔT_1	+ 1.2	+ 1.1	+ 0.3	+ 0.2	+ 0.9	+ 1.4	+ 0.2	+ 0.4	+ 0.8	− 0.3	− 0.1	(+ 0.2)
ΔT_2	+ 0.8	+ 1.0	+ 0.4	+ 0.3	+ 0.8	+ 1.1	− 0.1	+ 0.4	+ 0.4	− 0.5	− 0.5	(− 0.7)

Table 5. Mean values and monthly anomalies of surface salinity for 1960 (referred to 1902—1928 and 1953—1960) at fixed positions on the Hamburg—Hull route

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Year	**Position I; 54°09′N, 07°32′E**											
1902/28 .	32.00	32.60	32.00	31.00	32.20	31.00	32.40	32.50	32.50	32.60	33.10	33.00
1953/60 .	33.29	33.47	33.17	32.63	32.56	32.31	32.33	32.55	32.73	33.20	33.32	33.32
1960	33.95	33.91	34.33	33.99	33.37	33.01	33.78	33.04	33.28	33.80	32.91	33.13
ΔS_1	+ 1.95	+ 1.31	+ 2.33	+ 2.99	+ 1.17	+ 2.01	+ 1.38	+ 0.54	+ 0.78	+ 1 20	− 0.19	+ 0.13
ΔS_2	+ 0.66	+ 0.44	+ 1.16	+ 1.36	+ 0.81	+ 0.70	+ 1.45	+ 0.49	+ 0.55	+ 0.60	− 0.41	− 0.19
	Position II; 54°18′N, 06°12′E											
1902/28 .	34.50	34.50	34.40	34.20	34.00	33.90	33.90	34.00	34.05	34.40	34.40	34.50
1953/60 .	34.44	34.29	34.34	34.19	33.90	33.54	33.83	33.95	34.25	34.24	34.50	34.55
1960	34.59	(34.90)	34.78	34.42	34.50	34.29	34.51	34.20	34.72	34.43	34.56	34.67
ΔS_1	+ 0.09	(+ 0.40)	+ 0.38	+ 0.22	+ 0.50	+ 0.39	+ 0.61	+ 0.20	+ 0.67	+ 0.03	+ 0.16	+ 0.17
ΔS_2	+ 0.15	(+ 0.61)	+ 0.44	+ 0.23	+ 0.60	+ 0.75	+ 0.68	+ 0.25	+ 0.47	+ 0.19	+ 0.06	+ 0.12
	Position III; 54°19′N, 05°21′E											
1902/28 .	34.65	34.60	34.55	34.50	34.30	34.30	34.20	34.30	34.35	34.55	34.55	34.55
1953/60 .	34.66	34.61	34.44	34.42	34.29	34.18	34.27	34.36	34.39	34.40	34.57	34.64
1960	34.87	(35.08)	34.84	34.49	34.25	34.56	34.67	34.66	34.50	34.50	34.43	34.65
ΔS_1	+ 0.22	(+ 0.48)	+ 0.29	− 0.01	− 0.05	+ 0.26	+ 0.47	+ 0.36	+ 0.15	− 0.05	− 0.12	+ 0.10
ΔS_2	+ 0.21	(+ 0.47)	+ 0.40	+ 0.07	− 0.04	+ 0.38	+ 0.40	+ 0.30	+ 0.11	+ 0.10	− 0.14	+ 0.01
	Position IV; 54°10′N, 04°26′E											
1902/28 .	34.70	34.65	34.65	34.60	34.55	34.55	34.40	34.40	34.55	34.65	34.65	34.70
1953/60 .	34.66	34.65	34.59	34.59	34.55	34.44	34.53	34.58	34.57	34.61	34.71	34.69
1960	34.78	34.63	34.59	34.73	34.82	34.68	34.78	34.68	34.44	34.58	34.54	34.57
ΔS_1	+ 0.08	− 0.02	− 0.06	+ 0.13	+ 0.27	+ 0.13	+ 0.38	+ 0.28	− 0.11	− 0.07	− 0.11	− 0.13
ΔS_2	+ 0.12	− 0.02	± 0.00	+ 0.14	+ 0.27	+ 0.24	+ 0.25	+ 0.10	− 0.13	− 0.03	− 0.17	− 0.12
	Position V; 54°00′N, 03°32′E											
1902/28 .	34.65	34.70	34.70	34.70	34.50	34.55	34.55	34.55	34.70	34.70	34.65	34.70
1953/60 .	34.73	34.72	34.67	34.71	34.65	34.61	34.59	34.67	34.67	34.71	34.75	34.72
1960	34.74	34.81	34.75	34.79	34.64	34.72	34.78	34.85	34.72	34.64	34.60	34.63
ΔS_1	+ 0.09	+ 0.11	+ 0.05	+ 0.09	+ 0.14	+ 0.17	+ 0.23	+ 0.30	+ 0.02	− 0.06	− 0.05	− 0.07
ΔS_2	+ 0.01	+ 0.09	+ 0.08	+ 0.08	− 0.01	+ 0.11	+ 0.19	+ 0.18	+ 0.05	− 0.07	− 0.15	− 0.09
	Position VI; 53°53′N, 02°43′E											
1902/28 .	34.65	34.70	34.75	34.75	34.50	34.50	34.65	34.65	34.70	34.65	34.65	34.70
1953/60 .	34.75	34.76	34.70	34.74	34.74	34.70	34.70	34.70	34.72	34.73	34.73	34.72
1960	34.72	34.81	34.77	34.69	34.66	34.71	34.72	34.90	34.84	34.68	34.60	(34.76)
ΔS_1	+ 0.07	+ 0.11	+ 0.02	− 0.06	+ 0.16	+ 0.21	+ 0.07	+ 0.25	+ 0.14	+ 0.03	− 0.05	(+ 0.06)
ΔS_2	− 0.03	+ 0.05	+ 0.07	− 0.05	− 0.08	+ 0.01	+ 0.02	+ 0.20	+ 0.12	− 0.05	− 0.13	(+ 0.04)
	Position VII; 53°45′N, 01°54′E											
1902/28 .	34.60	34.65	34.75	34.75	34.65	34.65	34.65	34.60	34.65	34.60	34.60	34.65
1953/60	34.72	34.77	34.73	34.78	34.80	34.77	34.72	34.65	34.64	34.70	34.67	34.70
1960	34.82	34.77	34.75	34.73	34.82	34.77	34.67	34.82	34.74	34.62	34.60	(34.80)
ΔS_1	+ 0.22	+ 0.12	± 0.00	− 0.02	+ 0.17	+ 0.12	+ 0.02	+ 0.22	+ 0.09	+ 0.02	± 0.00	(+ 0.15)
ΔS_2	+ 0.10	± 0.00	+ 0.02	− 0.05	+ 0.02	± 0.00	− 0.05	+ 0.17	+ 0.10	− 0.08	− 0.07	(+ 0.10)

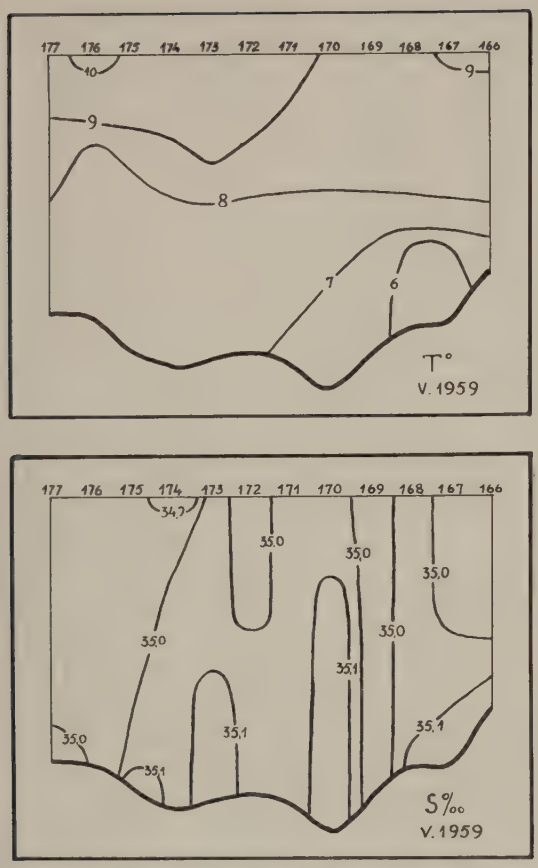


Figure 56. Section along 56°N, 01°W and 56°N, 04°E. Temperature and salinity, May 1959.

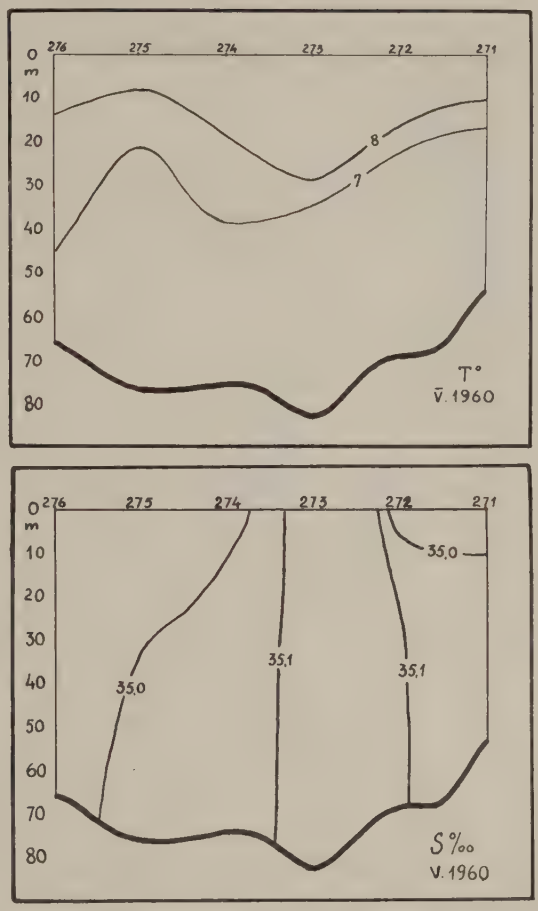


Figure 57. Section along 56°N, 01°W and 56°N, 04°E. Temperature and salinity, May 1960.

Polish Observations in the Central North Sea, 1959 and 1960

(Figures 56–64)

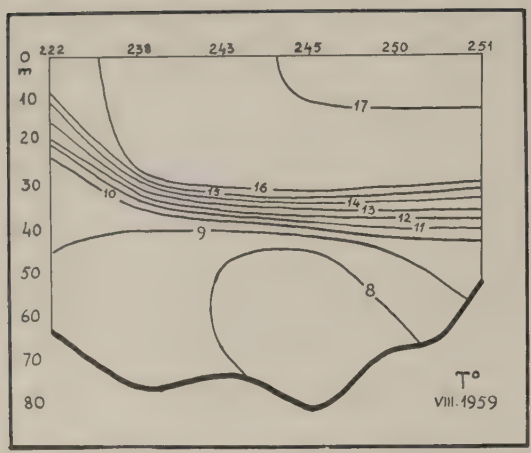
The hydrographical work was conducted in May and in August/September as a continuation of the 1958 research.

The observations during spring/summer covered the southern part of the Fladen Ground and the fishing grounds in that area, but during summer/autumn the area of the Dogger Bank was investigated.

Comparison of the temperature data shows that the bottom temperatures were lower in 1960 than in 1959. The differences for May amounted to about −0.45°C (Fladen Ground area), and for the months of August and September to about −2°C (Dogger Bank area).

Figures 56—64 illustrate temperature conditions and salinity distribution in the periods under consideration, special attention being paid to the bottom layers.

J. Filarski



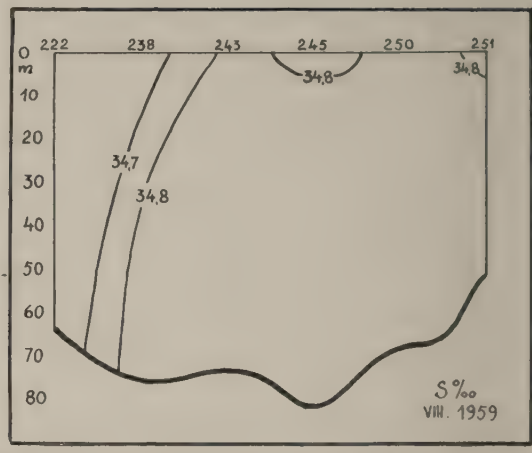
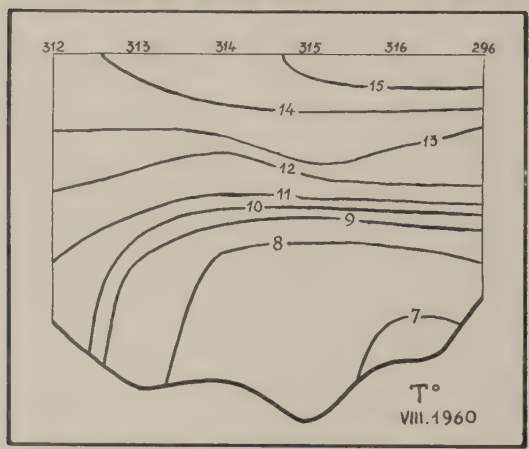


Figure 58. Section along 56°N. 01°W and 56°N, 04°E. Temperature and salinity, August 1959.



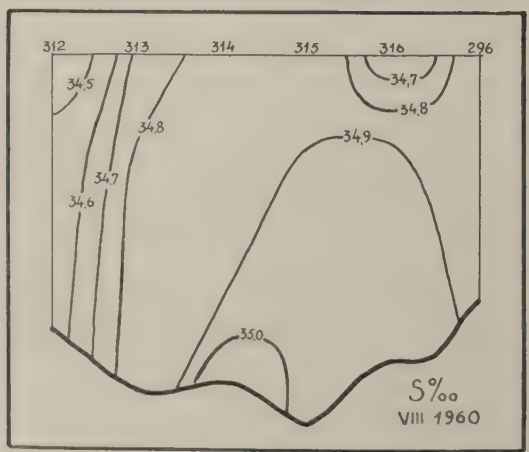


Figure 59. Section along 56°N, 01°W and 56°N, 04°E. Temperature and salinity, August 1960.

Figure 60. Bottom temperature and salinity, May 1959.

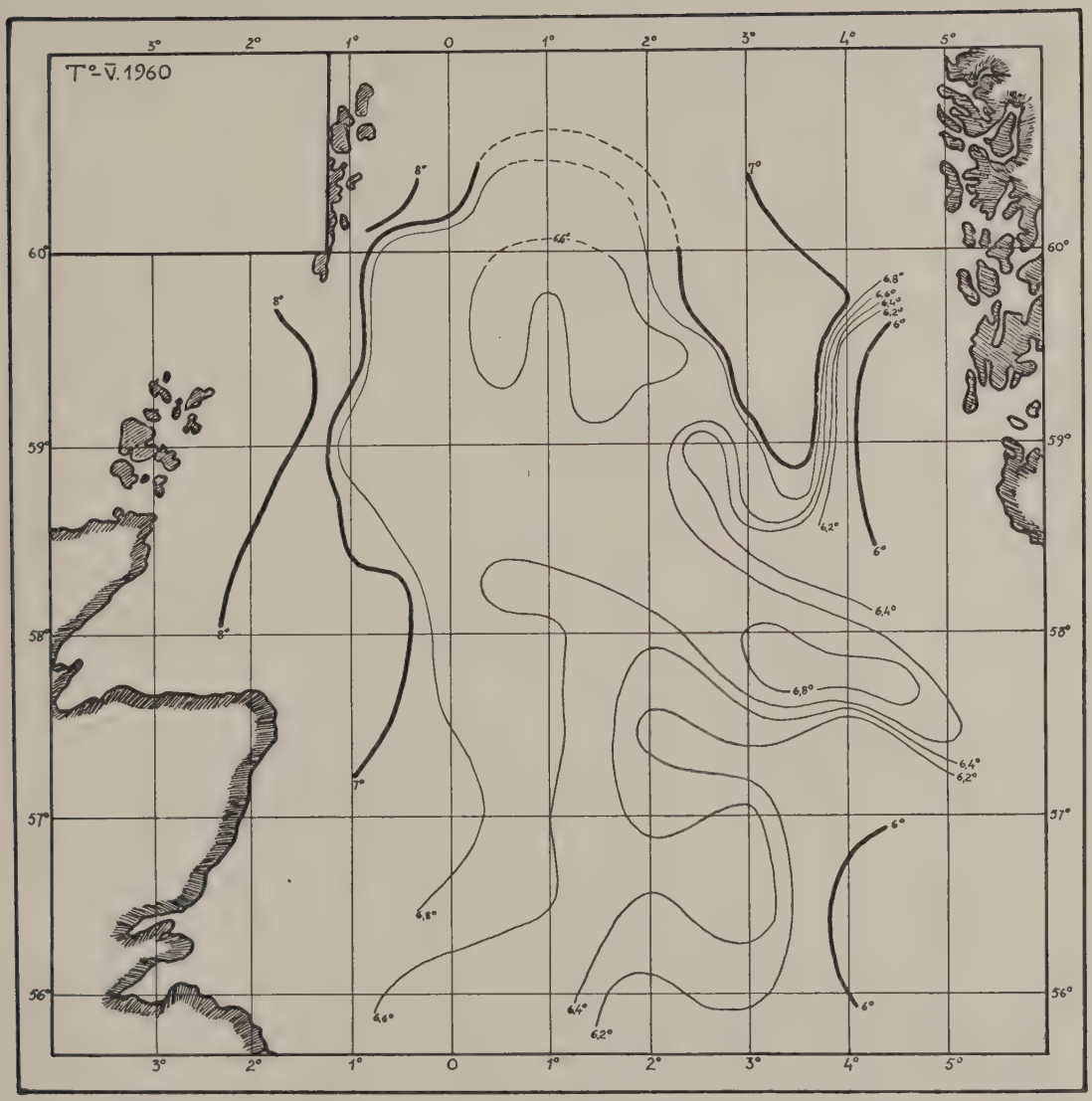


Figure 61. Bottom temperature, May 1960. Observations north of 58°N were made by R. V. "Professor Henking", Rostock; observations south of 58°N were made by R. V. "Birkut", Gdynia.

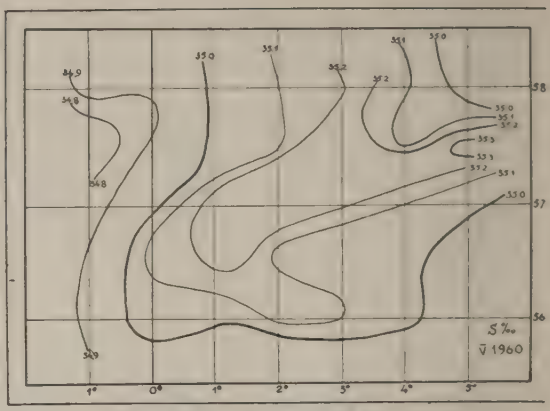


Figure 62. Bottom salinity, May 1960.

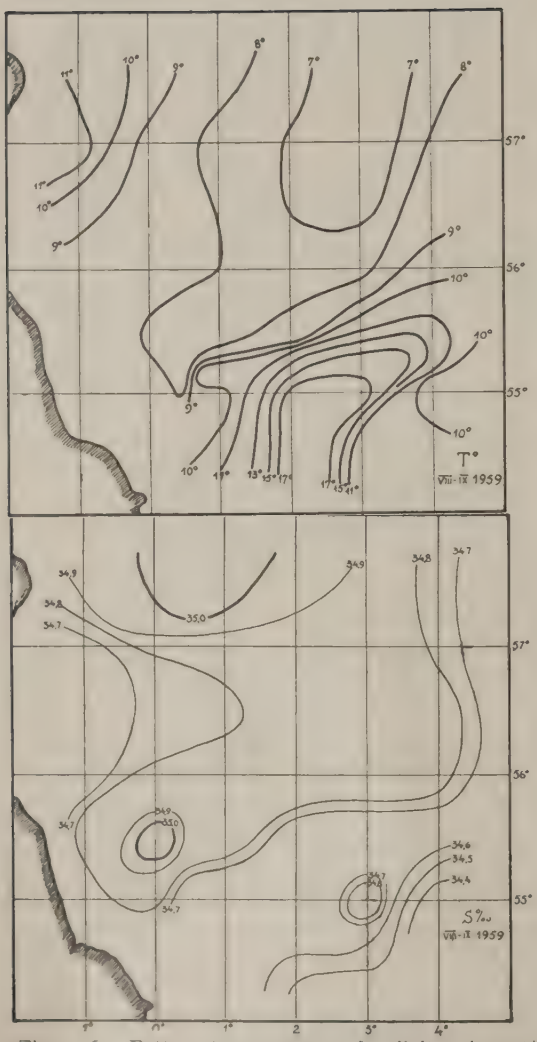


Figure 63. Bottom temperature and salinity, August/September 1959.

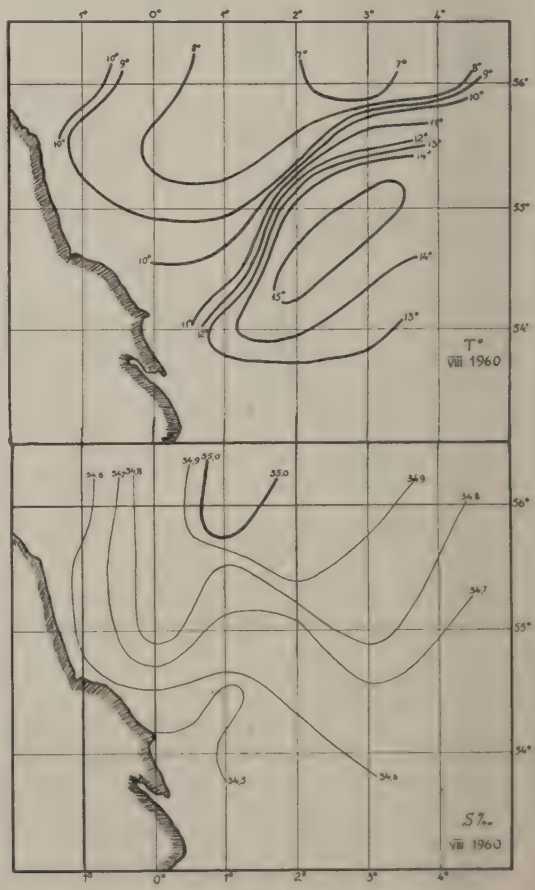


Figure 64. Bottom temperature and salinity, August 1960.

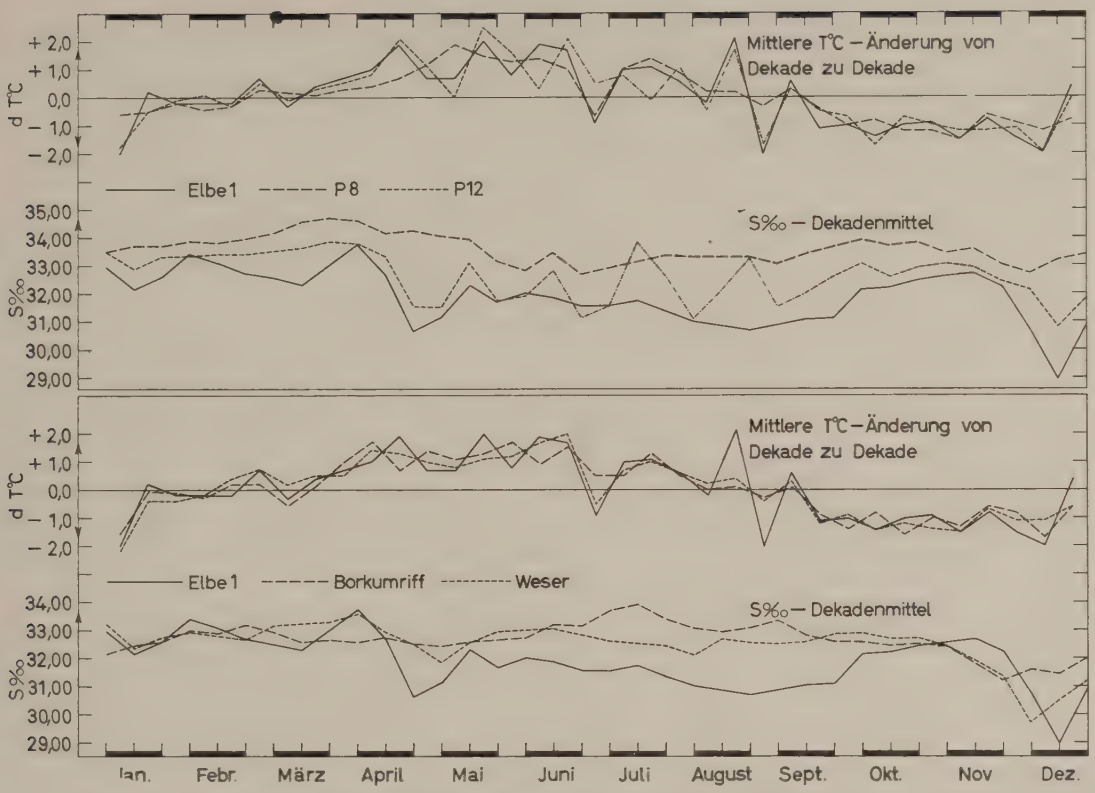


Figure 65. Mean temperature variation from decade to decade (ten-day means) and mean salinity decades (ten-day means) at the German lightvessels in the German Bight.

Hydrographic Conditions in the German Bight in 1960

(Figure 65; Tables 6–7)

Daily surface observations of temperature and salinity at 8h GMT were continued in 1960 from five German lightvessels, viz., "Borkumriff", "P 8", "P 17", "Weser", and "Elbe 1". This conforms with the routine commenced in 1949, with the exception of "Borkumriff" where observations were started in 1954. (For positions, see Ann. Biol., **14**: 60.) The data collected will be published in full in "Meereskundliche Beobachtungen und Ergebnisse". The monthly means of the surface observations, presented in Table 6, together with the means over a period of ten years, 1950/59 (for "Borkumriff" 1954/60) give a good impression of the hydrographical conditions in the estuaries and coastal waters of the German Bight. The mean values of the bottom oberservations carried out from the "Borkumriff", from which subsurface observations at various depths were made once a week, are also presented in Table 6, together with the means over a period of seven years, 1954/60. It should be noted that the monthly means of "P 12" for the period June to September have been computed from observations which German commercial vessels made on the Hamburg-Hull route (see Ann. Biol., **16**: 51).

In comparison with the long-term means, surface temperatures were comparatively high in the months of February, March, June, and again from September to December; on the other hand, they were relatively low in January, May, and again from July to August. The 1960 surface salinities were rather high in the German Bight in the period January to October and comparatively low during the last two months of the year as compared with the long-term monthly means.

Table 6. Monthly means of temperature and salinity at surface and bottom for 1950/59 (1954/60) and 1960 at the German lightvessels "Borkumriff", "P 8", "P 12", "Elbe 1", and "Weser"

(From Deutschen Hydrographischen Institut, Hamburg)

Month			I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Temperature							*Surface*							
"Borkumriff"	Mean	1954/60	4.8	3.5	3.1	5.5	9.0	12.9	16.0	17.4	16.7	14.0	10.3	7.2
		1960	4.4	3.6	3.4	5.6	9.3	13.3	15.9	17.4	16.9	13.9	10.5	7.5
							Bottom							
	Mean	1954/60	5.1	3.8	3.2	5.5	8.9	12.9	16.0	17.3	16.8	14.2	10.5	7.3
		1960	4.9	3.9	3.6	5.8	9.2	12.9	16.1	17.3	(16.6)	14.2	10.6	7.6
							Surface							
"P 8"	Mean	1950/59	5.4	3.7	3.4	5.1	8.8	12.8	15.7	16.9	16.4	14.0	10.9	7.7
		1960	5.1	4.0	4.2	5.1	8.7	13.3	14.5	16.8	16.8	14.6	11.2	8.3
							Surface							
"P 12"	Mean	1950/59	4.7	3.0	3.2	5.5	9.4	13.1	16.0	17.1	16.1	13.4	10.4	7.2
		1960	4.0	3.2	3.5	5.4	9.1	(13.2)	(15.8)	(17.2)	(16.4)	14.2	11.0	7.3
							Surface							
"Elbe 1"	Mean	1950/59	3.9	2.5	3.0	5.6	9.3	12.9	16.1	17.2	16.2	13.1	9.8	6.5
		1960	3.9	3.0	3.4	5.6	9.0	13.2	15.2	16.8	16.7	13.9	10.7	6.9
							Surface							
"Weser"	Mean	1950/59	3.8	2.6	3.0	5.4	8.8	12.7	15.9	17.2	16.1	13.1	9.8	6.4
		1960	3.6	2.2	3.4	5.7	8.9	12.9	15.1	16.9	16.6	13.6	9.8	6.7
Salinity														
							Surface							
"Borkumriff"	Mean	1954/60	32.65	32.22	32.36	32.35	32.43	32.55	32.77	32.62	32.80	32.85	32.72	32.60
		1960	32.41	33.03	32.74	32.61	32.56	33.04	33.69	33.03	32.91	32.54	31.80	31.68
							Bottom							
	Mean	1954/60	32.92	32.47	32.53	32.49	32.56	32.62	32.74	32.72	32.95	32.93	32.92	32.67
		1960	32.61	33.18	32.80	32.60	32.84	33.20	33.56	32.92	(32.65)	32.70	31.98	32.21
							Surface							
"P 8"	Mean	1950/59	33.63	33.59	33.32	33.26	32.79	32.63	32.83	32.86	33.02	33.44	33.72	33.65
		1960	33.63	33.85	34.48	34.33	33.70	32.97	33.36	33.30	33.38	33.80	33.35	33.11
							Surface							
"P 12"	Mean	1950/59	32.39	32.19	32.15	31.32	31.40	31.43	31.85	31.90	31.72	32.15	32.64	32.75
		1960	33.24	33.37	33.68	32.89	32.11	(32.27)	(32.89)	(32.13)	(32.41)	32.88	32.80	31.60
							Surface							
"Elbe 1"	Mean	1950/59	31.24	31.08	30.85	30.53	30.74	31.16	31.21	31.24	31.16	31.21	31.72	31.74
		1960	32.57	33.07	32.64	32.37	31.72	31.79	31.55	30.84	31.00	32.28	32.52	30.16
							Surface							
"Weser"	Mean	1950/59	31.60	31.72	31.96	31.95	32.13	32.13	32.16	32.05	31.86	31.87	32.21	32.1
		1960	32.81	32.82	33.22	33.01	32.47	32.97	32.53	32.45	32.65	32.80	31.88	30.498

Table 7. Annual mean of surface temperature and salinity in 1960

Lightvessel	"Borkumriff"		"P 8"		"P 12"		"Elbe 1"		"Weser"	
	t°C	S ‰	t°C	S ‰	t°C	S ‰	t°C	S ‰	t°C	S ‰
Mean 1950/59										
(1954/60) ..	10.1	32.60	10.1	33.22	9.9	31.94	9.7	31.16	9.6	31.99
1960	10.1	32.67	10.2	33.61	(10.0)	(32.69)	9.9	31.88	9.6	32.51

Table 7 shows that the annual means of salinity are rather high in reference to the long-term annual means.

The positive and negative anomalies of t°C and S‰ may be of some importance for biological problems in relation to the fishery.

1960 was again a remarkable year. The reason is to be found in the general weather situation over western and central Europe. The first half of the year was characterized by high air temperatures and a continuous drought over this part of the continent. The summer of 1960 (July/August) was abnormally cold and wet. The last quarter of the year, on the other hand, was rather mild and too wet[1]).

It is therefore of interest to know the short-range variations of temperature and salinity at the surface in the German Bight. In Figure 65 the deviations of the surface temperature from the long-term means are presented from decade to decade, together with the salinity means per decade.

Surface temperatures reveal greater fluctuations in the summer of 1960 as a result of the cold weather conditions in these months. The decrease of the surface salinity, for instance in December, may be ascribed to the great surplus of precipitation and run-off from the Rivers Elbe and Weser.

E. Goedecke

[1]) Deutscher Wetterdienst, Seewetteramt: Die Witterung in Übersee, 8. Jahrg., Nos. 1—12, Abschnitt Europa. Hamburg, 1960.

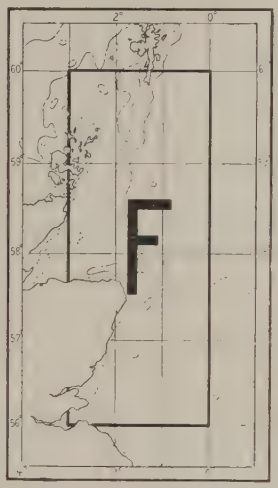


Figure 66. Location of area.

Monthly Anomalies of the Surface Temperature in an Area off the Eastern Coast of Scotland in 1960

(Figure 66; Table 8)

Table 8 gives for each month of 1960 the anomaly of the surface temperature in the area F (56°N—60°N, 0°—3°W; see Figure 66). As standards were used the grand monthly means for 1°-squares over the period 1876—1915.

Table 8. Monthly anomalies (Δ°C) and numbers (n) of observations of the surface temperature in the North Sea area F in 1960

Jan.		Feb.		March		April		May		June		July	
Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n
1.3	8	0.5	14	0.2	12	0.5	31	0.8	18	1.9	20	0.4	15

Aug.		Sept.		Oct.		Nov.		Dec.		Average
Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	of Δ-values
1.1	26	1.3	22	0.8	12	0.6	20	1.0	10	0.9

It appears from Table 8 that the anomaly is positive for each month of 1960. Averaged over the year the anomaly is 0.9°C, as compared with 1.1°C in 1959.

Jens Smed

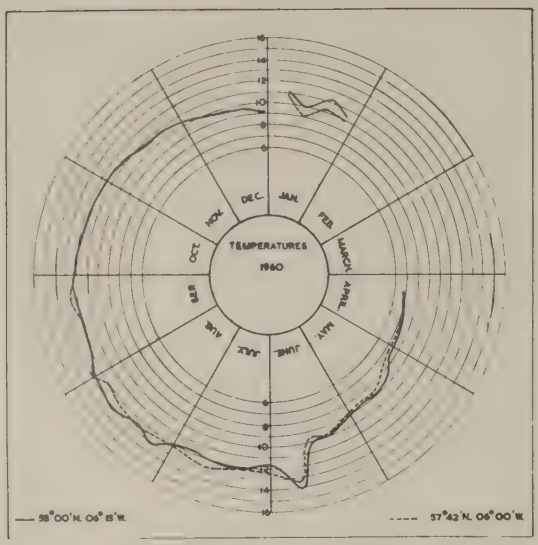


Figure 67. Sea temperature at 3 m depth at two positions in the North Minch, compiled from weekly observations.

Upper Water Temperature in the North Minch, 1960

(Figure 67)

In Figure 67 is shown the variation of sea temperature at 3 m depth at two stations. These data are from a thermograph on R.M.S. "Loch Seaforth" and the Department of Agriculture and Fisheries for Scotland is indebted to Messrs. David MacBrayne and Captain Smith for the records.

The temperature was about 1° below the usual value in January to May. It then rises to a short peak in June when it is about 1° above the usual value. The values then decrease smoothly to an average or rather low value in December.

R. E. Craig

Hydrography of the Kattegat Area
Danish Waters

(Tables 9–10)

At the lightvessel "Anholt Nord" the surface temperatures were a little below normal in the period February to April and again from July to November, with the greatest deviation in July. The bottom temperatures were more irregular; temperatures below normal were prevailing, especially in March, August, October, and November.

The surface salinities were unusually high from January to July, and unusually low in October. The bottom salinity values were above normal or normal throughout the year, and especially high from August to November.

G. Stougård Nielsen

Swedish Waters

(Tables 11–12)

The salinities of the deeper layers of the north-eastern Kattegat were above normal during all months of the year 1960, June excepted. At 40 m

Table 9. Monthly means of salinity and temperature at surface and bottom at the lightvessel "Anholt Nord" for a longer series of years, and deviations from these means
(From the Danish Meteorological Institute, Nautical Department)

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Salinity					*Surface*							
Mean 1931—60 ...	23.5	23.3	21.2	20.4	18.1	18.5	19.6	20.0	20.5	21.8	22.1	23.3
Deviation 1960 ...	3.1	2.5	2.4	2.5	4.9	5.3	3.1	0.3	−0.3	−4.1	−0.3	1.2
					Bottom (30 m)							
Mean 1931—60 ...	33.0	33.0	33.1	33.6	33.6	33.5	32.9	32.6	32.6	32.7	33.1	33.0
Deviation 1960 ...	0.2	0.5	0.8	0.6	0.6	0.0	0.6	1.2	0.9	1.5	1.6	0.7
Temperature					*Surface*							
Mean 1931—60 ...	2.4	1.2	1.8	4.7	9.9	14.5	17.4	17.7	15.4	11.6	7.8	4.9
Deviation 1960 ...	0.5	−0.7	−0.4	−0.2	0.4	0.6	−1.1	−0.3	−0.1	−0.9	−0.5	0.0
					Bottom (30 m)							
Mean 1931—60 ...	6.7	5.2	4.6	4.7	4.9	6.5	9.6	12.5	13.4	12.9	11.0	8.7
Deviation 1960 ...	−0.5	0.3	−1.1	−0.8	−0.3	0.7	0.0	−1.3	0.3	−1.2	−1.6	0.5

Table 10. Monthly means of salinity and temperature at surface and bottom at the lightvessel "Vyl" for a longer series of years, and deviations from these means

(From the Danish Meteorological Institute, Nautical Department)

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Salinity					*Surface*							
Mean {1888—1917, 1921—1930}	32.6	32.4	32.2	32.4	32.3	32.6	32.5	32.4	32.6	32.4	32.4	32.9
Deviation 1960 ...	1.8	1.5	1.6	1.1	1.7	1.4	1.2	0.9	0.6	0.5	0.9	0.2
					Bottom (20 m)							
Mean {1888—1917, 1921—1930}	32.9	32.7	32.7	32.7	32.6	33.0	32.8	32.6	32.7	32.6	32.6	33.0
Deviation 1960 ...	1.6	1.3	1.3	1.1	1.6	1.1	1.0	1.0	0.6	0.6	1.0	0.2
Temperature					*Surface*							
Mean {1888—1917, 1921—1930}	3.2	2.2	2.6	4.8	8.8	12.4	15.2	16.1	15.0	12.2	8.5	5.4
Deviation 1960 ...	1.8	0.7	0.4	0.0	−1.0	0.0	−1.2	0.1	1.2	1.4	2.0	2.0
					Bottom (20 m)							
Mean {1888—1917, 1921—1930}	3.8	2.6	3.0	4.8	8.0	11.1	14.1	16.0	15.1	12.7	9.1	6.2
Deviation 1960 ...	1.1	0.2	0.0	−0.2	−0.4	0.5	−0.4	−0.2	1.2	1.1	1.6	1.2

depth the mean value at "Vinga" was as high as 34.9‰ in October. From 5. to 15. October and again from 27. October to 6. November the salinity value was here over 35‰ every day, 35.25‰ being the maximum value. The mean salinity of the surface water was at "Vinga" not less than 5.0‰ below the normal value for the month of October (see Table 11).

In the Skagerak Deep measurements were not taken after July. During this period the warm and

Table 11. Monthly means of salinity and temperature in 1960 at surface and bottom for the Swedish lightships "Vinga" and "Svinbådan", and deviations from the 1950—1959 means

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Salinity					*Surface*							
"Vinga"	28.8	26.8	24.9	25.4	19.8	24.5	25.2	24.1	22.3	19.8	23.1	26.6
Deviation	+ 4.1	+ 3.2	+ 2.7	+ 3.8	−1.0	+ 3.8	+ 3.4	+ 2.0	−1.7	−5.0	−0.9	+ 1.1
"Svinbådan"	19.8	16.3	14.0	16.8	13.3	15.3	14.6	14.5	12.8	—	—	—
Deviation	+ 4.3	+ 1.2	+ 0.2	+ 3.5	+ 0.9	+ 2.4	+ 0.8	+ 1.1	−2.6	—	—	—
					Bottom							
"Vinga"	34.0	34.3	34.6	34.6	34.4	33.9	33.9	34.0	34.0	34.9	34.5	33.9
Deviation	+ 0.1	+ 0.1	+ 0.4	+ 0.2	± 0	−0.1	+ 0.2	+ 0.5	+ 0.5	+ 1.4	+ 0.5	± 0
"Svinbådan"	29.7	31.3	32.6	31.9	31.3	28.4	31.0	31.0	31.8	—	—	—
Deviation	+ 1.8	+ 2.8	+ 2.5	+ 0.6	+ 0.6	−1.5	+ 3.1	+ 3.7	+ 5.1	—	—	—
Temperature					*Surface*							
"Vinga"	3.2	0.1	1.1	4.5	10.6	15.5	16.3	17.1	15.4	10.3	6.9	5.0
Deviation	+ 0.8	−1.0	−0.8	± 0	+ 0.8	+ 1.1	−0.8	−0.2	+ 0.2	−1.5	−1.0	−0.1
"Svinbådan"	2.6	0.5	1.7	4.9	9.6	15.2	16.1	17.4	14.8	—	—	—
Deviation	+ 0.3	−0.8	−0.3	+ 0.3	+ 0.1	+ 0.7	−1.0	+ 0.2	−0.3	—	—	—
					Bottom							
"Vinga"	6.2	5.0	4.3	5.0	5.2	7.0	9.3	12.2	12.5	9.0	9.0	8.3
Deviation	± 0	± 0	−0.7	+ 0.2	−0.4	+ 0.2	+ 0.2	+ 1.1	−0.3	−3.3	−0.9	+ 0.3
"Svinbådan"	5.4	4.5	4.9	4.5	5.2	8.9	8.7	9.8	9.5	—	—	—
Deviation	−0.2	± 0	+ 0.2	−0.5	−0.5	+ 1.5	−1.7	−2.5	−3.1	—	—	—

Table 12

	Depth	M 6 58°10′N 09°30′E			R 43 58°25′N 09°44′E	
		Date				
	m	13/1	10/2	10/3	20/4	27/7
Salinity	0	33.35	33.55	33.90	25.34	32.15
	10	33.39	33.55	33.90	25.47	33.86
	20	33.39	33.74	33.98	32.08	34.43
	30	33.48	34.19	33.98	33.92	34.53
	50	34.54	34.64	34.70	34.37	34.74
	100	34.93	34.82	34.88	34.85	34.73
	200	35.20	35.13	34.94	34.96	35.05
	400	35.22	35.21	35.20	35.09	35.10
	600	—	35.22	35.20	35.23	35.18
Temperature	0	6.02	4.17	4.48	4.99	16.32
	10	6.08	4.22	4.51	4.39	8.87
	20	6.02	4.75	4.48	4.38	5.80
	30	6.17	6.52	4.74	4.62	5.59
	50	7.94	7.26	6.85	5.67	6.11
	100	8.27	7.03	6.81	6.59	5.61
	200	7.36	7.61	6.58	6.13	6.07
	400	6.00	6.35	6.38	6.18	6.17
	600	—	5.78	5.80	5.95	5.90
O_2 ml/l	600	5.73	5.69	5.60	5.50	5.31
PO_4-P μg-at./l	600	0.93	0.94	0.87	0.77	1.00

saline water masses which had intruded in 1959 (S = 35.34‰, t = 8° C) decreased somewhat in heat and salt contents (see Table 12).

ARTUR SVANSSON

Chemical Observations

(Figures 68–84)

These results relate chiefly to chemical conditions in the western part of the northern North Sea during the last four months of 1960, and also to November 1959. Some of these samplings were undertaken to supplement international herring surveys. Temperature and salinity charts (Figs 68 and 69) for 1959 have been included; for the four cruises in 1960, temperature and salinity distributions are illustrated (Figs. 43—47), on pp. 41—44 in the contribution by R. E. CRAIG. Figures 68—84 depict surface conditions.

November 1959

Temperature and salinity. Figures 68 and 69 show for this month abnormally high temperatures and maximum oceanic character for the last ten years. The November surface temperatures resembled those of September 1958 and 1957 and were 1°—1 1/2°C above normal. The proximity of the 34.9‰ isohaline to the coast shows much reduced coastal conditions, probably in association with the prolonged drought over the British Isles.

Phosphate. Striking departures from average conditions are evident in Figure 71 (Nov. 1959). Except for two values < 0.5 μg-at. PO_4-P/l in an area where in 1958 and 1957 (this journal, Vol. XV, p. 40, Figs. 55 and 54) the highest values of > 0.6 were found, the main body of water had a phosphate content of above 0.5. In November 1960 (Fig. 79) low phosphate, < 0.5, predominated. A small patch of low phosphate in the east lies within the low salinity water from the southern North Sea circulation which in 1960, 1958, and 1957 was considerably farther south. High phosphate, > 0.6, and slightly lower oxygen content and saturation accompany richer-than-usual oceanic water that has moved southwards from a site in October to the north of 59°30′N, extending from 1°W to 3°E. High phosphate was also found in low salinity water south of the Firth of Forth in which winter mixing had been completed.

Oceanic water made a greater contribution to phosphate replenishment in the North Sea in November 1959 than previously reported in these contributions.

Oxygen (Fig. 70). This 1959 chart also bears evidence of the lateness of the seasonal overturn. Low values in the north (5.9 cc O_2/l and 98—99% saturation) and supersaturation in the south (> 6.0 cc O_2/l and 100—110%) contrast with the fairly average oxygen distribution for November 1960 (Fig. 78), with high values in the north, low in the south, and overall 2—3% undersaturation. The high values > 6.3 cc O_2/l and 105% saturation in the south perhaps mark some transitory phytoplankton activity in the surface layers, though winter mixing was well advanced in most of the region. The patch of high phosphate (> 0.6 μ) in the east accompanied reduced oxygen saturation (97%).

1960. The four cruises presented here succeed one another at short intervals from 11. September to 17. December.

Temperature and salinity. Temperatures for these last four months of 1960 were on a par with 1958, being 3/4 to 1 1/4°C above normal in September and 1/4 to 1°C above normal in December. Oceanic flow north of Shetland in September was very weak, but some incursion of high salinity water (> 35.3‰) had taken place apparently through the Fair Isle—Shetland Channel. The increased penetration usually detectable towards the end of the year seemed to be absent in November 1960. Coastal water defined by the 34.9‰ isohaline was more abundant in November and December 1960 than in 1959, in keeping with an increased rainfall.

Figure 68. Temperature °C. 7.—25. November 1959.

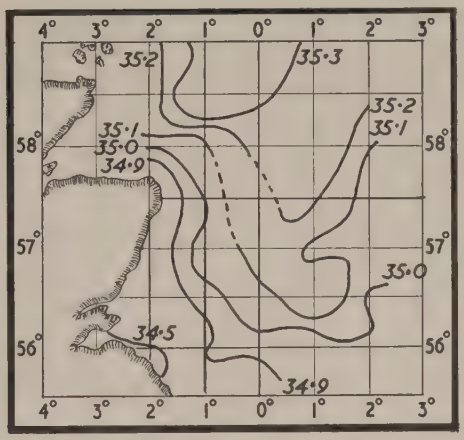


Figure 69. Salinity ‰, 7.—25. November 1959.

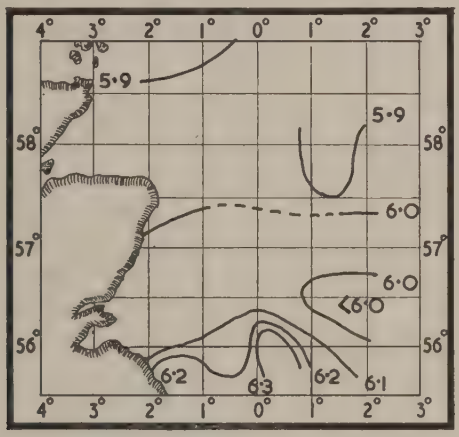


Figure 70. Dissolved oxygen cc O_2/l, 7.—25. November 1959.

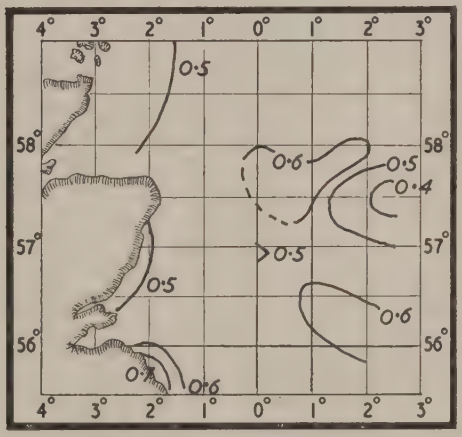


Figure 71. Free phosphate µg-at. PO_4–P/l, 7.—25. November 1959.

Phosphate (Figs. 73, 76, 79, 82). September values showed extensive depletion except in coastal regions, compared to 1958 and 1956[1]). In October regeneration had begun to spread from the west, continuing in November and December. Coastal water in December 1960 had a lower phosphate content than in December 1957. The evidence suggests that the autumn of 1960 displayed a lower than usual phosphate level.

Oxygen (Figs. 72, 75, 78, 81). September values were typical for the time of year with saturations of 100—102%, except in oceanic water of the Fair Isle gap and also in inshore water where mixing had reduced saturation to 98—99%. October showed little change in the absolute and saturation values. In November and December, with mixing more or less completed, saturation values had mostly fallen to 97—98%, except in the SE corner (near the Dogger Bank) where they ranged from 93—95%, and in the vicinity of the Firth of Forth where 6.2 cc O_2/l was recorded and saturation reached 99%.

Silicate (Figs. 74, 77, 80, 83). Surface distributions of this element are here included for the first time. The chart for December 1960 (Fig. 83) must be regarded as more reliable than those preceding (Figs. 74, 77, 80) when methods for preservation and examination were still being developed. In December highest values (> 6 µg-at. Si/l) were associated with coastal waters and, of two zones of low silicate (> 3), that in the north was associated with oceanic water and that in the south with indigenous North Sea water of low phosphate and

[1]) see Ann. Biol., 13: 61.

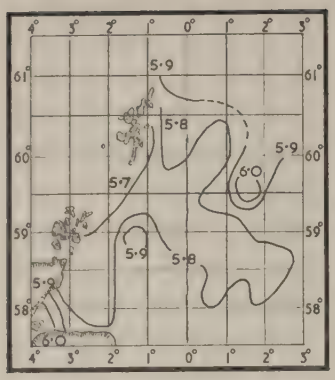


Figure 72. Dissolved oxygen cc O_2/l, 11.—29. September 1960.

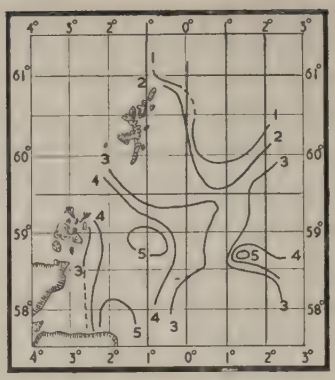


Figure 73. Free phosphate µg–at. PO_4–P/l, 11.—29. September 1960.

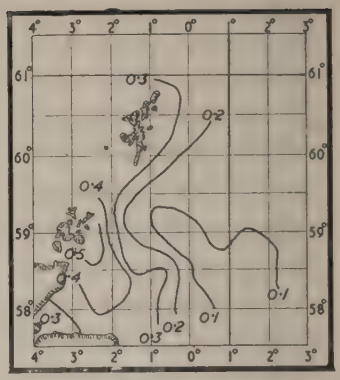


Figure 74. Silicate µg–at. Si/l, 11.—29. September 1960.

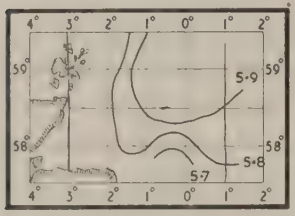


Figure 75. Dissolved oxygen cc O_2/l, 15.—18. October 1960.

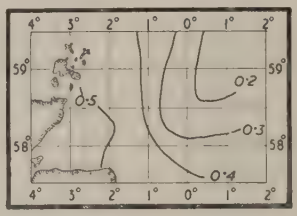


Figure 76. Free phosphate µg–at. PO_4–P/l, 15.—18. October 1960.

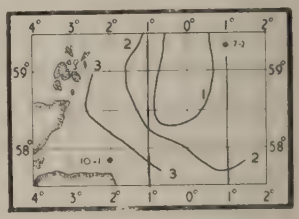


Figure 77. Silicate µg–at. Si/l, 15.—18. October 1960.

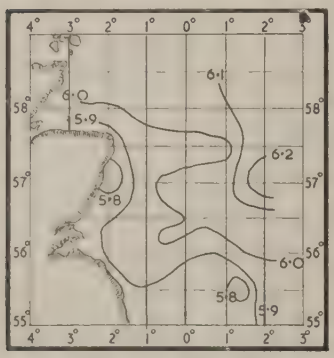


Figure 78. Dissolved oxygen cc O_2/l, 7.—25. November 1960.

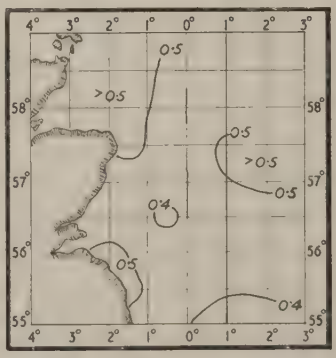


Figure 79. Free phosphate µg–at. PO_4–P/l, 7.—25. November 1960.

Figure 80. Silicate µg–at. Si/l, 7.—25. November 1960.

relatively high temperature. In November also, low silicates were evident in the south but the very few silicate values for the north poorly demarcate the oceanic element. In September, before regeneration of the surface layers has begun, silicate distribution followed the general trend of phosphate. Notably, surface oceanic water had a low silicate content (< 1) while superficial Baltic outflow, though poor in phosphate, was markedly higher in silicate (> 3).

Nitrate (Fig. 84). Nitrate followed in general the distribution of phosphate, namely, low in the south and high in the north, and was roughly in step with salinity, which would indicate that oceanic water is the main replenishing source of this element in the North Sea. Nitrogen/phosphorus ratios ranged from 9 : 1 in the south to 15 : 1 in the north with 16 : 1 for bottom oceanic water in the Fladen area. Since the N/P ratio for plankton organisms is about 14 : 1, this trend emphasizes

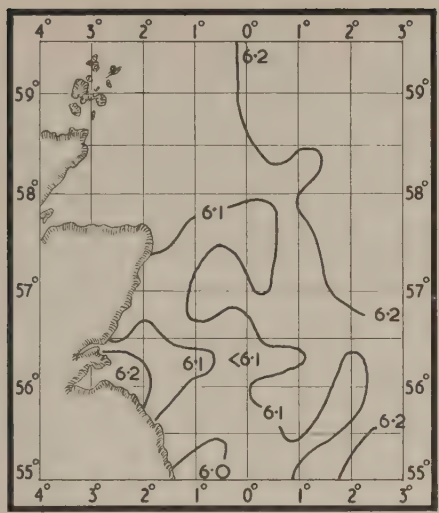


Figure 81. Dissolved oxygen cc O_2/l, 5.—17. December 1960.

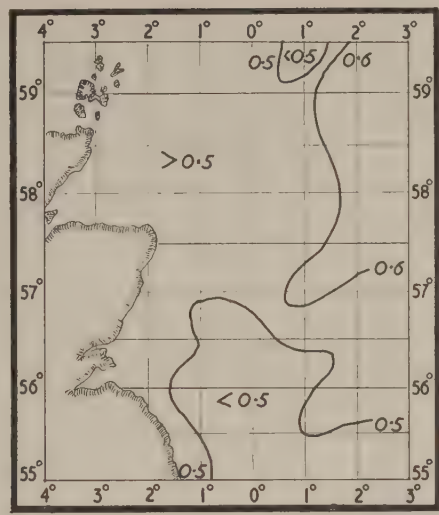


Figure 82. Free phosphate µg–at. PO_4–P/l, 5.—17. December 1960.

Figure 83. Silicate µg–at. PO_4–P/l, 5.—17. December 1960.

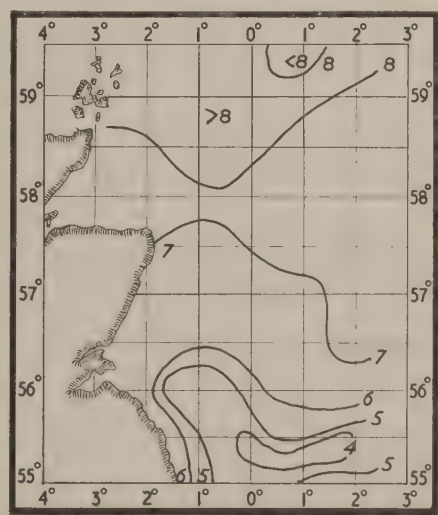


Figure 84. Nitrate µg–at. NO_3–N/l, 5.—17. December 1960.

that replenishment of nitrate in the North Sea is probably of relatively greater importance than replenishment of phosphate. Within the area of lowest nitrate one position gave a ratio of only 7.6 : 1.

General. The end of 1959 showed later than average winter overturn, strong oceanic inflow, and water conditions suggestive of better than average nutrient content. In direct contrast, autumn 1960 was marked by normal winter overturn, feeble oceanic incursion, and below average nutrient conditions.

R. B. Burns and R. Johnston

Errata. Vol. XV (1959) 1960, p. 39:—
Fig. 44 read Free phosphate µg–at. PO_4–P/l
Fig. 45 read Dissolved oxygen cc O_2/l
Fig. 46 read Salinity $^0/_{00}$
Fig. 47 read Temperature °C.

C. Baltic-Belt Seas

Table 13. Monthly means of salinity and temperature at surface and bottom at the lightvessel "Halsskov Rev" for a longer series of years, and deviations from these means

(From the Danish Meteorological Institute, Nautical Department)

Month	I	II	III	IV	V	VI[1])	VII	VIII	IX	X	XI	XII
Salinity					*Surface*							
Mean 1931—60 ...	17.4	17.1	14.6	14.6	12.3	13.7	14.0	14.0	15.4	16.7	15.8	17.4
Deviation 1960 ...	3.9	0.1	−0.1	2.4	2.8	—	0.2	−0.5	−2.4	−4.2	0.6	1.9
					Bottom (20 m)							
Mean 1931—60 ...	22.8	23.0	22.2	26.6	27.9	30.5	30.0	28.1	26.2	23.6	22.5	23.1
Deviation 1960 ...	2.6	−0.2	3.2	2.4	−3.0	—	−2.1	2.1	1.3	−0.7	4.8	2.2
Temperature					*Surface*							
Mean 1931—60 ...	2.3	1.4	1.9	4.8	9.4	13.9	17.0	17.3	15.3	11.6	7.8	4.6
Deviation 1960 ...	0.7	−1.1	−0.3	0.3	−0.1	—	−1.6	−0.6	−0.2	−0.3	0.2	0.8
					Bottom (20 m)							
Mean 1931—60 ...	4.1	2.9	2.9	4.5	6.1	7.0	8.9	11.6	13.2	12.1	9.3	6.3
Deviation 1960 ...	−0.6	−1.8	−0.7	−0.4	0.8	—	1.7	−1.1	−0.8	−0.3	0.5	−0.2

[1]) The lightvessel "Halsskov Rev" was withdrawn from 14.—29. June.

Table 14. Monthly means of salinity and temperature at surface and bottom at the lightvessel "Gedser Rev" for a longer series of years, and deviation from these means

(From the Danish Meteorological Institute, Nautical Department)

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Salinity					*Surface*							
Mean 1931—60 ...	12.0	11.5	10.2	9.8	8.9	9.2	9.5	9.6	10.5	11.6	11.3	12.2
Deviation 1960 ...	1.8	−0.5	−0.6	1.1	0.1	0.5	−0.4	−0.8	−1.5	−2.6	0.5	0.1
					Bottom (15 m)							
Mean 1931—60 ...	14.1	14.2	13.6	14.4	14.4	14.7	14.8	15.3	16.0	15.7	13.8	14.4
Deviation 1960 ...	1.8	−0.5	0.6	1.9	2.7	0.7	−1.0	0.1	−1.8	−1.8	0.0	1.1
Temperature					*Surface*							
Mean 1931—60 ...	2.4	1.4	1.7	4.1	8.0	12.9	16.3	16.7	15.1	11.8	8.2	4.9
Deviation 1960 ...	0.3	−0.8	−0.6	0.1	−0.1	1.3	−2.3	−0.6	−1.1	−0.4	0.0	0.9
					Bottom (15 m)							
Mean 1931—60 ...	3.0	1.7	1.8	3.5	6.1	10.1	13.2	14.6	14.4	12.3	8.9	5.5
Deviation 1960 ...	−0.1	−1.1	−0.9	0.0	0.9	2.1	0.1	0.2	−0.4	−0.5	−0.1	0.6

Table 15. Monthly means of salinity and temperature at Christianso for a longer series of years and deviations from these means

(From the Danish Meteorological Institute, Nautical Department)

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Salinity												
Mean 1898—1930 .	7.0	7.0	7.0	7.0	7.0	7.2	7.4	7.2	7.0	7.0	7.1	7.0
Deviation 1960 ...	0.9	1.0	1.1	1.0	0.9	1.0	1.0	0.7	0.7	0.3	0.0	0.2
Temperature												
Mean 1898—1930 .	3.3	2.1	1.8	3.0	6.1	11.0	15.2	16.0	14.1	11.1	8.1	5.5
Deviation 1960 ...	0.9	−0.2	−0.4	−0.1	−0.3	1.2	−0.4	0.5	0.3	−0.3	−0.3	0.2

H. Thomsen

German Observations in the Western Baltic, 1960

(Figure 85; Tables 16–18)

Routine daily surface observations (at 8^h GMT) of temperature and salinity were continued in 1960 at three German lightvessels (for position, see Ann. Biol., **14**: 90). The data will be published in full in "Meereskundliche Beobachtungen und Ergebnisse". Monthly means of observations are given in Table 16 in comparison with the ten-year means, 1950/59. Hydrographical subsurface observations were made daily at "Fehmarnbelt" L.V. only.

The observations made at "Kiel" and "Flensburg" L. V. illustrate the conditions in the western parts of the Baltic where there are no strong currents; the observations at "Fehmarnbelt", however, cover regions in which both in-going and out-going currents of considerable strength occur.

Almost throughout the year the surface temperatures were comparatively low, as compared with the ten-year period 1950/59. Surface salinities had positive anomalies (referred to 1950/59) during the period February to July and negative anomalies during the second half of the year.

Positive anomalies of the bottom temperature occurred in January and in the periods May to August and October to December. Negative anomalies were computed for February/April and September.

The bottom waters near the "Fehmarnbelt" L.V. showed high salinity values in January and June, and during the period August to December; low values were observed only in February/March, May, and July.

On the whole it is very remarkable that the annual means of surface temperature and salinity

Table 16. Monthly means of temperature and salinity at surface and bottom for the period 1950/59 and 1960 at the German lightvessels "Flensburg", "Kiel", and "Fehmarnbelt"

(From Deutsches Hydrographisches Institut Hamburg)

Month			I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Temperature							*Surface*							
"Flensburg"	Mean	1950/59	2.8	1.2	1.6	4.6	9.5	14.0	16.4	16.8	15.1	12.0	8.1	5.2
		1960	2.5	0.5	1.3	4.0	9.3	14.3	14.5	17.1	15.7	11.6	8.4	5.6
							Surface							
"Kiel"	Mean	1950/59	2.6	1.2	1.7	4.8	9.4	14.0	16.9	17.2	15.4	12.0	8.4	5.1
		1960	2.4	0.5	1.2	4.0	9.2	15.0	15.3	17.1	15.3	11.9	8.4	5.1
							Surface							
"Fehmarnbelt"	Mean	1950/59	2.8	1.3	1.8	4.8	9.1	13.7	16.8	17.2	15.4	12.1	8.4	5.2
		1960	2.8	0.5	1.3	4.5	8.8	15.2	15.0	16.9	14.9	11.6	8.5	5.7
							Bottom							
	Mean	1950/59	3.6	2.3	2.4	3.8	5.3	6.9	8.4	10.3	12.2	12.1	9.6	6.0
		1960	4.2	1.1	1.2	3.7	6.0	7.0	9.6	11.3	12.0	12.2	10.7	7.6
Salinity							*Surface*							
"Flensburg"	Mean	1950/59	19.46	18.20	16.72	16.14	14.92	14.85	15.85	16.58	17.43	18.46	18.52	19.14
		1960	18.99	19.12	18.26	16.33	16.84	17.43	19.31	15.58	16.35	14.01	14.23	18.74
							Surface							
"Kiel"	Mean	1950/59	18.81	17.61	16.36	15.29	13.91	13.53	14.17	14.89	15.53	17.83	18.06	18.69
		1960	17.92	19.47	18.24	16.58	15.58	14.77	17.34	13.41	14.41	13.82	14.04	17.00
							Surface							
"Fehmarnbelt"	Mean	1950/59	15.24	13.15	12.39	12.42	10.97	11.41	12.32	12.08	14.13	15.12	14.01	15.88
		1960	17.08	15.10	12.31	14.69	12.04	13.10	13.14	11.29	11.54	10.80	13.33	15.42
							Bottom							
	Mean	1950/59	19.70	20.24	20.07	23.98	26.30	27.68	28.13	26.61	24.82	22.12	20.36	20.36
		1960	22.44	19.80	19.79	23.96	23.92	28.45	26.22	27.14	26.21	24.72	24.96	26.35

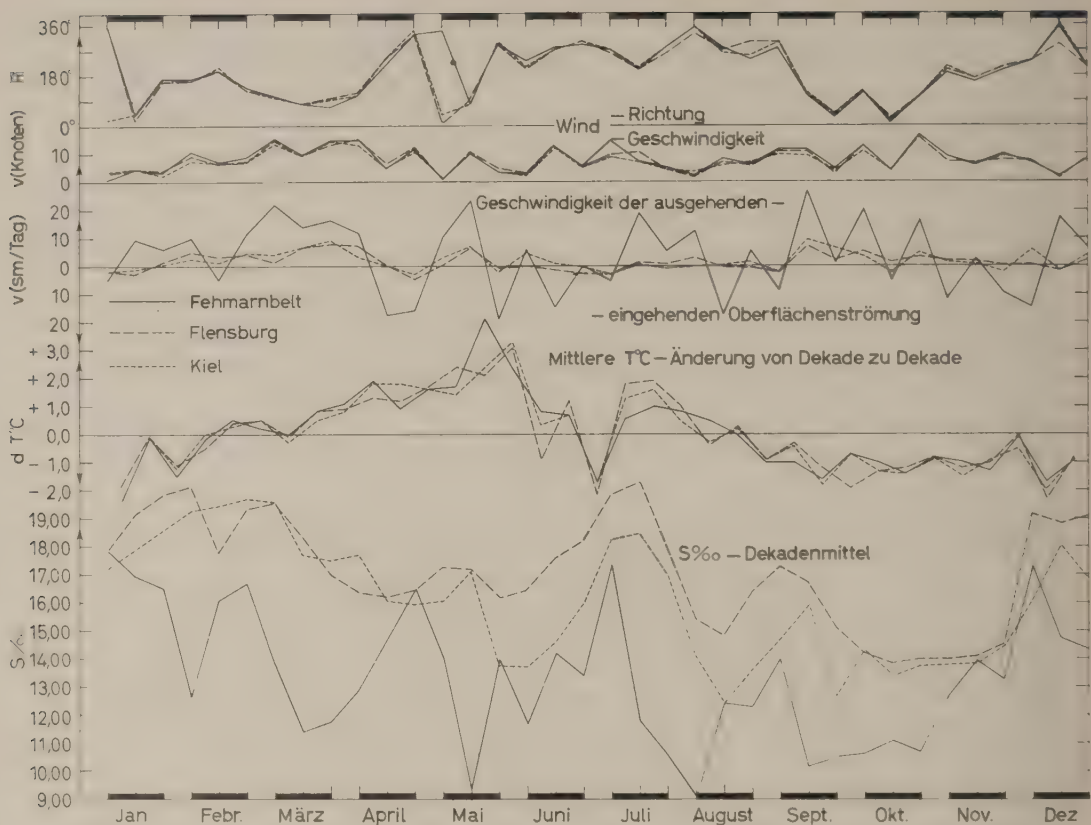


Figure 85. Wind, current, temperature, and salinity conditions at the surface of the western Baltic in 1960 (expressed as 10-day means).

Table 17. Annual means of surface temperature and salinity in 1960

Lightvessel	"Flensburg"		"Kiel"		"Fehmarnbelt"	
	t°C	S ‰	t°C	S ‰	t°C	S ‰
Mean 1950/59	8.9	17.19	9.1	16.18	9.1	13.26
1960	8.7	17.10	8.8	16.05	8.8	13.32

Table 18. Ten-day means of surface temperature at three German lightvessels during the period May to July 1960

Month	10-day period	"Flensburg" °C	"Kiel" °C	"Fehmarnbelt" °C
May	First	6.9	7.4	7.3
	Second	9.3	8.8	8.0
	Third	11.4	11.2	12.1
June	First	14.5	14.5	14.4
	Second	13.6	14.8	15.2
	Third	14.8	15.6	15.9
July ...	First	**12.6**	**13.9**	**14.2**
	Second	14.4	15.2	14.8
	Third	16.3	16.8	15.8

(Table 17) show almost negative anomalies, referred to 1950/59, at all three lightvessels.

Figure 85 presents the wind, current, temperature, and salinity conditions at the surface in 1960, expressed by ten-day means. The curves for all the hydrographic elements are in good agreement. The out-going current was temporally predominant in January/March, May, July, September, October, and December. Simultaneous with this increased outflow a sharp decrease in the surface salinity took place.

In this connection mention shall only be made of the meteorological and hydrographical features during the period May to July. Very warm air masses of continental and maritime origin overflowed alternately wide areas of western and central Europe during the second half of May up to the end of June. After a sudden change-over in the general atmospheric circulation at the beginning of July, Polar air masses entered wide areas of

northern and central Europe[1]) resulting in a remarkable decrease in air and sea temperatures in the Baltic (see Table 18 and Figure 85).

The most characteristic feature of the meteorological conditions during the entire month of July 1960 was the predominance of cold air masses of Polar origin. July 1960 is therefore one of the coldest months on record for over 40 years, for instance, in comparison with the temperature records of the Potsdam Observatory for the period 1893/1960. This abnormally cold month can also be compared with the still colder July of 1954[2]). The features described above resulted in rather low mean surface temperatures prevailing over the entire western Baltic during 1960. In-going currents due to winds from the west were predominant during the same period. Therefore the surface salinity values increased in the western Baltic and remained at this level for a long period.

E. Goedecke

[1]) Meteorologischer u. Hydrologischer Dienst der DDR: Tägliche Wetterberichte für die Monate Mai bis Juli. Leipzig, 1960.

[2]) Unger, E. "Ungewöhnlich kühler Juli 1960?" Tägl. Wetterber., 14: 241—44. Leipzig, 1960.

Table 19. Monthly means of salinity and temperature in 1960 at surface and bottom at Swedish lightships with deviations from the 30-year means

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Salinity					*Surface*							
"Sydostbrotten" ...	—	—	—	—	—	4.4	4.5	5.1	5.1	5.5	5.8	5.8
Deviation	—	—	—	—	—	−0.3	+0.2	+0.8	+0.5	+0.6	+0.6	+0.5
"Finngrundet"	5.9	—	—	—	—	5.8	5.7	5.6	5.5	5.6	5.6	5.7
Deviation	+0.5	—	—	—	—	+0.3	+0.3	+0.3	+0.3	+0.3	+0.2	+0.4
"Svenska Björn"	6.6	6.5	—	—	6.2	5.8	5.7	5.8	5.7	5.9	6.3	6.2
Deviation	+0.4	+0.3	—	—	+0.3	+0.1	+0.2	+0.3	+0.1	±0	+0.2	+0.1
"Falsterborev"	8.4	8.3	7.6	7.7	8.0	8.0	8.3	8.1	7.8	7.3	7.4	8.5
Deviation	+0.2	+0.2	−0.2	+0.2	+0.6	+0.5	+0.4	+0.2	−0.2	−1.1	−0.9	+0.2
"Oskarsgrundet"	10.2	9.0	8.0	12.2	9.2	10.9	10.1	12.8	8.8	8.0	11.1	11.8
Deviation	−0.9	−2.3	−2.2	+2.7	+0.8	+1.1	+0.2	+3.2	−2.0	−3.8	+0.6	−0.2
					Bottom							
"Sydostbrotten"	—	—	—	—	—	5.8	5.8	5.9	5.7	6.0	6.0	5.9
Deviation	—	—	—	—	—	+0.2	+0.1	+0.2	+0.1	+0.4	+0.4	+0.3
"Finngrundet"	5.9	—	—	—	—	5.8	5.7	5.8	5.7	5.7	5.6	5.7
Deviation	+0.1	—	—	—	—	+0.1	−0.1	+0.1	−0.1	±0	−0.1	±0
"Svenska Björn"	6.7	6.6	—	—	6.7	6.8	6.7	6.4	6.7	6.7	6.8	6.8
Deviation	−0.2	−0.1	—	—	−0.1	−0.6	−0.6	−1.3	−0.5	−0.6	−0.1	±0
"Falsterborev"	8.5	8.4	7.6	7.8	8.1	8.1	8.4	8.2	8.0	7.7	7.4	8.6
Deviation	±0	+0.1	−0.2	+0.2	+0.6	+0.5	+0.3	±0	−0.2	−1.0	−0.9	+0.1
"Oskarsgrundet"	16.5	12.9	10.4	16.1	13.3	16.3	13.3	15.3	11.8	11.8	20.5	14.4
Deviation	+2.9	−0.9	−3.2	+3.7	+3.5	+4.1	+1.8	+4.5	−0.9	−2.2	+6.4	−0.1
Temperature					*Surface*							
"Sydostbrotten"	—	—	—	—	—	11.1	14.5	15.7	13.2	7.9	4.5	2.5
Deviation	—	—	—	—	—	+2.7	+0.4	+0.3	+1.3	+0.2	−0.3	−0.7
"Finngrundet"	(1.7)	—	—	—	—	9.8	13.6	15.3	12.3	7.2	5.2	3.7
Deviation	+0.1	—	—	—	—	+2.5	−0.2	−0.3	+0.2	−0.8	+0.1	+0.7
"Svenska Björn"	2.7	(0.5)	—	—	5.0	11.6	14.8	16.4	13.7	9.6	6.7	4.5
Deviation	+0.3	−0.7	—	—	+0.8	+2.7	+0.1	+0.6	+0.6	+0.6	+0.1	+0.2
"Falsterborev"	2.9	0.8	1.2	3.4	8.2	13.2	14.5	16.7	14.5	11.5	8.2	5.8
Deviation	±0	−1.0	−0.8	−0.3	+0.4	+0.8	−1.3	+0.2	−0.2	−0.2	−0.2	+0.7
"Oskarsgrundet"	2.5	(0.6)	1.2	4.1	8.5	13.7	15.2	16.9	14.4	11.3	7.9	5.6
Deviation	−0.3	−1.3	−1.0	−0.2	+0.1	+0.6	−0.9	+0.2	−0.4	−0.1	−0.1	+0.9
					Bottom							
"Sydostbrotten"	—	—	—	—	—	1.3	1.4	4.7	5.2	6.9	4.2	2.9
Deviation	—	—	—	—	—	−0.7	−0.9	+2.1	+1.6	+0.7	−1.2	−1.2
"Finngrundet"	(1.8)	—	—	—	—	3.0	3.4	3.4	3.3	6.0	5.1	3.8
Deviation	+0.2	—	—	—	—	−1.5	−1.8	−1.9	−2.5	−0.5	±0	+0.9
"Svenska Björn"	2.7	(0.9)	—	—	1.9	2.5	3.3	4.3	5.0	8.1	7.8	5.5
Deviation	±0	−0.7	—	—	−0.5	−0.7	−0.5	−1.0	−0.6	+1.8	+1.7	+0.9
"Falsterborev"	2.8	0.8	1.1	3.3	7.3	11.2	13.4	16.2	13.7	11.4	7.9	5.7
Deviation	−0.1	−1.0	−0.9	−0.3	−0.2	−0.6	−1.2	+0.5	−0.9	−0.3	−0.5	+0.6
"Oskarsgrundet"	3.2	(1.4)	2.0	4.3	7.9	12.5	15.0	16.7	14.4	11.4	9.1	5.8
Deviation	−0.2	−1.0	−0.5	±0	−0.2	±0	−0.8	+0.2	−0.3	−0.1	+0.7	+0.5

Table 20. Hydrographic Data of the Deep Basins of the Baltic in 1960

Bornholm Deep
55°15′N, 15°59′E

Depth m	Temp. °C	S ‰	O_2 ml/l	PO_4–P µg-at./litre	Alkal. milli-val/l
		2. February			
0	2.86	7.83	—	0.22	—
10	2.90	7.82	8.87	0.24	—
30	2.87	7.82	8.84	0.21	—
50	3.60	8.04	8.61	0.24	
70	5.91	12.66	7.22	0.41	—
80	6.35	15.49	4.90	0.75	
		18. March			
0	1.53	6.44	—	0.17	
10	1.56	6.43	9.18	0.16	—
30	1.55	6.42	9.19	0.19	—
50	1.78	7.86	9.13	0.15	—
70	5.36	13.59	5.26	0.56	—
80	6.48	15.02	4.01	0.72	—
87	6.45	16.01	3.41	0.89	—
		26. August			
0	16.63	7.68	—	0.12	—
10	16.61	7.69	6.60	0.10	—
30	3.61	7.71	8.18	0.13	—
50	3.87	9.48	7.00	0.21	1.65
70	5.54	14.70	4.64	0.47	1.78
80	5.58	16.00	3.70	0.91	1.78
87	5.38	16.81	1.99	1.5	1.85
		31. October			
0	9.14	7.35	—	0.11	—
10	9.16	7.39	7.37	0.09	—
30	9.16	7.38	7.35	0.11	—
50	9.42	7.81	7.05	0.20	—
70	7.94	14.92	3.41	0.69	—
80	5.91	16.04	2.67	1.0	—
87	5.62	16.44	2.08	1.0	—

Gothland Deep
57°21′N, 19°57′E

Depth m	Temp. °C	S ‰	O_2 ml/l	PO_4–P µg-at./litre	Alkal. milli-val/l
		3. February			
0	2.02	7.54	8.86	0.21	—
70	4.20	9.56	2.06	0.99	—
100	4.80	10.66	0.92	1.14	—
150	6.07	12.21	0.98	4.04	—
200	5.61	12.81	0.00	7.7	—
225	5.66	12.95	0.00	8.6	—
		19. March			
0	0.03	6.97	—	0.27	—
70	3.21	8.06	5.53	0.52	—
100	4.99	10.15	—	0.77	—
150	5.92	11.15	0.60	1.49	—
200	5.55	12.17	0.00	5.7	—
220	5.61	12.28	0.00	6.5	—
		28. August			
0	14.85	7.11	7.16	0.04	1.44
70	3.78	9.20	3.44	0.48	1.61
100	5.11	10.74	1.98	0.86	—
150	5.23	11.97	0.55	2.6	1.70
200	5.60	12.75	0.00	7.0	1.91
215	5.62	12.76	0.00	5.4	—
		1. November			
0	8.04	7.16	7.64	0.10	—
70	4.34	9.91	2.33	0.76	—
100	5.32	11.37	1.87	1.0	
150	5.53	12.44	0.06	5.3	—
200	5.49	12.78	0.00	8.5	—
220	5.51	12.82	0.00	8.9	—

Landsort Deep
58°35′N, 18°14′E

Depth m	Temp. °C	S ‰	O_2 ml/l	PO_4–P µg-at./litre	Alkal. milli-val/l
		2. February			
0	1.38	7.00	—	0.29	—
70	3.64	8.23	5.31	0.44	—
100	4.17	9.39	2.05	1.46	—
150	4.23	10.02	—	1.69	—
200	4.33	10.14	0.52	1.72	—
425	4.44	10.47	0.29	1.84	—
		19. March			
0	0.02	6.70	—	0.32	—
70	1.96	7.50	8.00	0.48	—
100	4.21	9.32	1.32	1.35	—
150	4.36	9.68	0.65	1.52	—
200	4.34	9.79	0.43	1.58	—
425	4.44	10.03	0.11	1.58	—
		29. August			
0	14.64	6.05	—	0.11	—
70	3.45	8.86	2.88	1.0	—
100	4.49	10.03	0.90	1.8	—
150	4.94	10.55	0.55	1.9	—
200	4.99	10.60	0.52	1.9	—
430	5.09	10.84	0.47	1.9	—
		1. November			
0	8.08	6.63	—	0.12	
70	3.02	7.56	7.29	0.31	—
100	4.62	10.37	0.41	2.0	
145	4.87	10.54	0.40	2.1	—
194	4.92	10.67	0.37	2.2	—
387	5.06	10.78	0.44	2.1	—

Observations at Swedish Lightships and in the Central Baltic

(Tables 19-20)

The salinity in the Bothnian Sea is still above normal at the surface. At 30 m level the salinity is almost unchanged. The annual mean deviation at the „Finngrundet" lightship was at the surface +0.3‰ and at 30 m level ±0. The salinity in the deep water of the Landsort Deep has increased by ahout 0.3‰ but in the Gothland Deep the salinity still decreases and the stagnation continues. The inflow of Kattegat water into the Bornholm Basin has continued and the oxygen content is still about 2 ml/l at 80 m depth.

STIG H. FONSELIUS

Hydrographic Conditions in the Southern Baltic, 1960

(Figures 86–87; Table 21)

The winter 1959/60 was relatively mild and the surface temperatures in March did not fall below 1°C, ranging in the top water layer between 1.0° and 1.6°C. Table 21 shows, together with other features, the bottom temperatures at the most important stations and it may be seen that the bottom temperature in March in Bornholm Deep (and in the northern part of Gdansk Deep), at 97 m depth was lower than usual (about 3°C). In the southern part of Gdansk Deep, however, it was relatively high, even higher than that of January. The corresponding salinity in Bornholm Deep was also higher (by 1.6‰), if compared with that of October 1959, thus indicating a winter influx of

Table 21. Temperature (°C), salinity (‰), and oxygen content (ml/l) in the southern Baltic, 1960

Region			1960				1961
Arkona Basin (55°02′N, 14°02′E)		23. Mar.	1. June	24. Aug.	6. Oct.	26. Oct.	15. Feb.
T 0 m	—	1.35	9.71	16.35	12.40	11.01	2.71
S 0 m	—	8.22	7.95	7.79	7.59	8.08	7.67
T 45 m	—	1.10	4.80	11.80	11.60	12.00	3.52
S 45 m	—	13.04	20.86 (44 m)	16.22	17.45	17.38	19.69 (48 m)
O_2 45 m	—	8.08	4.65	4.29	0.67	1.69	—
Bornholm Deep (55°20′N, 15°45′E)		23. Mar.	1. June	24. Aug.	6. Oct.	25. Oct.[1])	14. Feb.[1])
T 0 m	—	1.50	10.05	15.80	11.55	9.48	3.31
S 0 m	—	7.94	7.68	7.03	7.32	7.29	7.57
T 95 m	—	3.30	4.28	5.28	5.55	6.42	6.48
S 95 m	—	16.67 (97 m)	17.25	16.76	16.23	16.38 (88 m ?)	16.80 (91 m)
O_2 95 m	—	2.16	—	1.82	1.88	1.28	—
Slupsk Furrow West (55°13′N, 17°05′E)		23. Mar.	1. June	25. Aug.	7. Oct.	25. Oct.	14. Feb.
T 0 m	—	1.50	9.40	16.20	12.00	9.59	3.06
S 0 m	—	7.85	7.50	7.43	7.41	7.48	7.34
T 90 m	—	5.88	5.30	5.50	—	6.49	7.09
S 90 m	—	13.13	13.80	14.24	—	14.62 (88 m)	13.55 (85 m)
O_2 90 m	—	4.95	2.53	3.98	—	2.85	—
Gdansk Deep North (55°12′N, 19°21′E)	13. Jan.	22. Mar.	2. June	26. Aug.			
T 0 m	2.70	1.50	8.68	16.78	—	—	—
S 0 m	7.54	7.67	7.59	7.48	—	—	—
T 95 m	8.00	2.8	7.55	5.11	—	—	—
S 95 m	11.71 (94 m)	11.22 (97 m)	11.87 (98 m)	11.96 (98 m)	—	—	—
O_2 95 m	—	2.64	—	2.71	—	—	—
Gdansk Deep South (55°50′N, 19°20′E)	12. Jan.	22. Mar.	3. June	26. Aug.	24. Oct.	17. Nov.	13. Feb.
T 0 m	3.55	1.10	10.60	17.50	8.66	7.05	2.98
S 0 m	7.50	7.76	7.23	7.30	7.61	7.67	7.32
T 105 m	6.98	8.30	7.87	6.70	5.76	5.57	5.52
S 105 m	11.62	12.23 (106 m)	12.16 (108 m)	11.96 (107 m)	—	12.48 (100 m)	12.30 (107 m)
O_2 105 m	—	2.81	0.53	4.82	—	—	—

[1]) 55°18′N, 15°58.5′E.

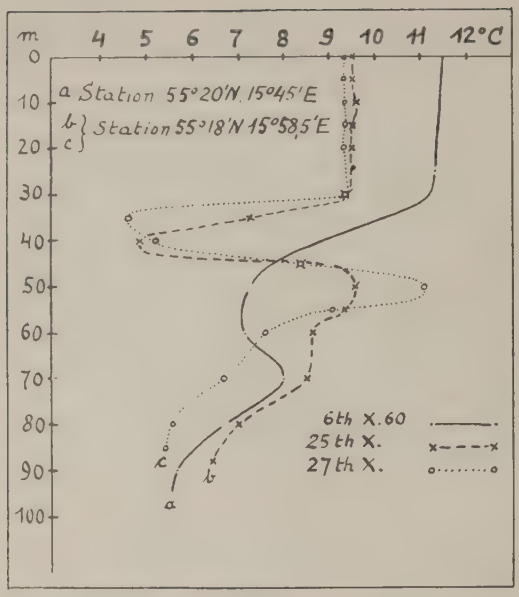


Figure 86. Temperatures in Bornholm Deep, October 1960.

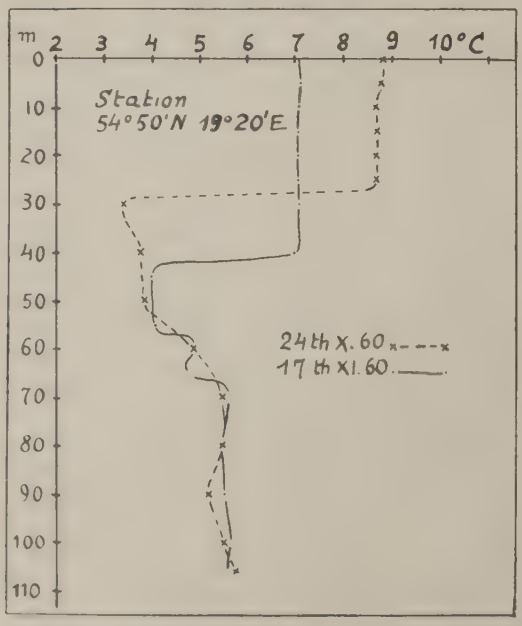


Figure 87. Temperatures in Gdansk Deep, October and November 1960.

more saline waters. The high bottom temperature in the southern Gdansk Deep was apparently connected with the very warm waters observed at the end of 1959 in the intermediate water layers in Bornholm Deep (over 13°C at 60—80 m).

At the beginning of July a very high salinity was observed in the Arkona Basin at 44 m depth. At the entrance to Bornholm Deep a value of 17.6‰ was observed at the same time. In Bornholm Deep proper the salinity value was 17.25‰, thus reaching the highest level observed there since 1955. The corresponding oxygen content indicated a marked renewal of the bottom waters (Table 21) The oxygen content in the bottom water of Gdansk Deep, particularly in the southern part, was very low at that time, as a result of an influx from the west of waters very poor in oxygen content.

The surface temperatures in August were about 16°C; the water layer having this temperature was rather thin while it was somewhat thicker in Gdansk Deep if we compare the western and eastern parts of the southern Baltic; temperatures between 4.8° and 7.7°C were generally found at 25 m depth, except in Gdansk Deep where such values occurred at 35 to 45 m depth.

Winter water with temperatures of about 3°C in Gdansk Deep and up to 5.5°C in Bornholm Deep were observed as late as at the end of August.

The bottom temperature in Bornholm Deep was increasing and that of Gdansk Deep was slowly falling until the end of 1960 when both reached the same value of about 5.5°C in October and November. The bottom salinity in Bornholm Deep was also decreasing (Table 21), in Gdansk Deep, however, it was oscillating throughout the year between 11.62‰ and 12.48‰.

At the end of October the surface layer down to a depth of 25 m was homogeneous as to temperature, which ranged between 8.5° and 9.5°C. In the Arkona Basin, however, a summer distribution of temperatures was observed which was by 1°C higher at the surface than at about 30 m depth, and, moreover, markedly higher than in other areas.

The temperatures of the deep water layers differed in the different regions. In Figure 86 the changes which took place in Bornholm Deep during October are depicted. On 6. October in position 55°20'N, 15°45'E, the temperature distribution was quite normal, but on the 25. and 27. of that month in position 55°18'N, 15°58.5'E, the conditions were such that it is anticipated that a very strong influx of warm water must have taken place at 50 m depth. For comparison, Figure 87 illustrates

the temperature conditions in the southern part of Gdansk Deep at the same time.

It may be added that, according to observations made by the Institute for Hydrology and Meteorology at Gdynia, a further influx of oceanic water into the Baltic is to be expected. This concept is supported by the fact that the bottom salinity, measured in February 1961 in a position more to the west of 15°22′E, had increased to a value of over 18.3‰, evidently caused by prevailing strong western winds.

A. Glowinska

D. Atlantic Area

Hydrographical Conditions along the 14° W Meridian South-West of Ireland, July 1960

(Figures 88–90; Table 22)

The English R. V. "Ernest Holt" worked a section along the 14°W meridian between 50°15′ and 52°44′N on 3.—7. July 1960. The position of the section in relation to the continental shelf is shown in Figure 88 A, together with the observed distributions of temperature, salinity, σ_t , and silicate-silicon (Fig. 88, B—D).

At stations 16 and 17, in addition to sampling at the usual standard depths, an attempt was made to sample at 25 m intervals between (a) 800 and 1000 m, (b) 1800 and 2000 m. Owing to the wire angle these closely spaced series sampled depths a little shallower than the desired depths. The profiles of potential temperature, salinity, and potential density below 1600 m depth are shown in Figure 89. Smooth curves can be drawn through the observations of temperature, salinity, and density at 1602, 1781, 1961, and 2556 m, but there are inflexions in the temperature and density profiles between 1800 and 2000 m and a marked salinity minimum. Between 1830 and 1880 m the salinity was consistently lower than the smooth curve by about 0.018‰, and the temperature was low by 0.04°C at 1854 and 1872 m. Cooper (1961) has already drawn attention, on the basis of observations made at a station 70 miles off the continental slope in the northern Bay of Biscay (Cavall, Fig. 88), to a highly heterogeneous water around a potential temperature of 3.8°C and a depth of 1900 m. He has termed it the Merlin Complex. The observations at station 16 support the idea of an intrusive plate of water, which originated as overflow of the Scotland-Faroes-Iceland-Greenland Ridge, centred on a depth of 1850 m, and associated with it a layer of water in neutral adiabatic equilibrium centred on 1815 m.

The profiles of temperature and salinity between 750 and 1050 m at stations 16 and 17 are given in Figure 90. The presence of a stratum of Gibraltar water of high salinity is immediately obvious, but the profiles also show that a certain degree of complexity was associated with it. At station 16 two isothermal layers are apparent: one between 849 and 922 m with a temperature of 9.82°C and another below it with a temperature of 9.60°C at 947 and 996 m and of 9.59°C at 972 m. At station 17 there was one isothermal layer between 848 and 872 m with a temperature of 9.59°C. Below this layer there was a semblance of a second one, in that the temperatures at 921 and 969 m were both 9.22°C, but at 945 m the temperature was 9.16°C, giving a slight temperature minimum. Thus the layers were thinner and cooler at station 17 than at station 16, and there is a suggestion that the second layer housed a temperature minimum.

At both stations there was a bicuspid distribution of salinity. The upper maxima were at 922 m at station 16 and 872 m at station 17, and at both stations they were at the bottom of the upper isothermal layer. The lower maxima were at the bottom bottle on both hoists, 996 m at station 16 and 993 m at station 17, so that the true maxima may have been deeper still. Further, at both stations they were at the bottom of the lower isothermal layer, but here the position was not so clear cut as at the base of the upper isothermal layer.

In Figure 88 C the trend of the isopycnals between stations 28 and 43 with the heaviest water at station 43 suggests a weak current flowing from west to east at all depths below 100 m down to the bottom. Between stations 28 and 24 the density gradient becomes steeper and the density at 360 m (i.e., 61 m above the bottom) at station 28 was almost identical with that at 512 m (i.e., 73 m above the bottom) at station 24, so that the isopycnals near the sea-bed were parallel with the continen-

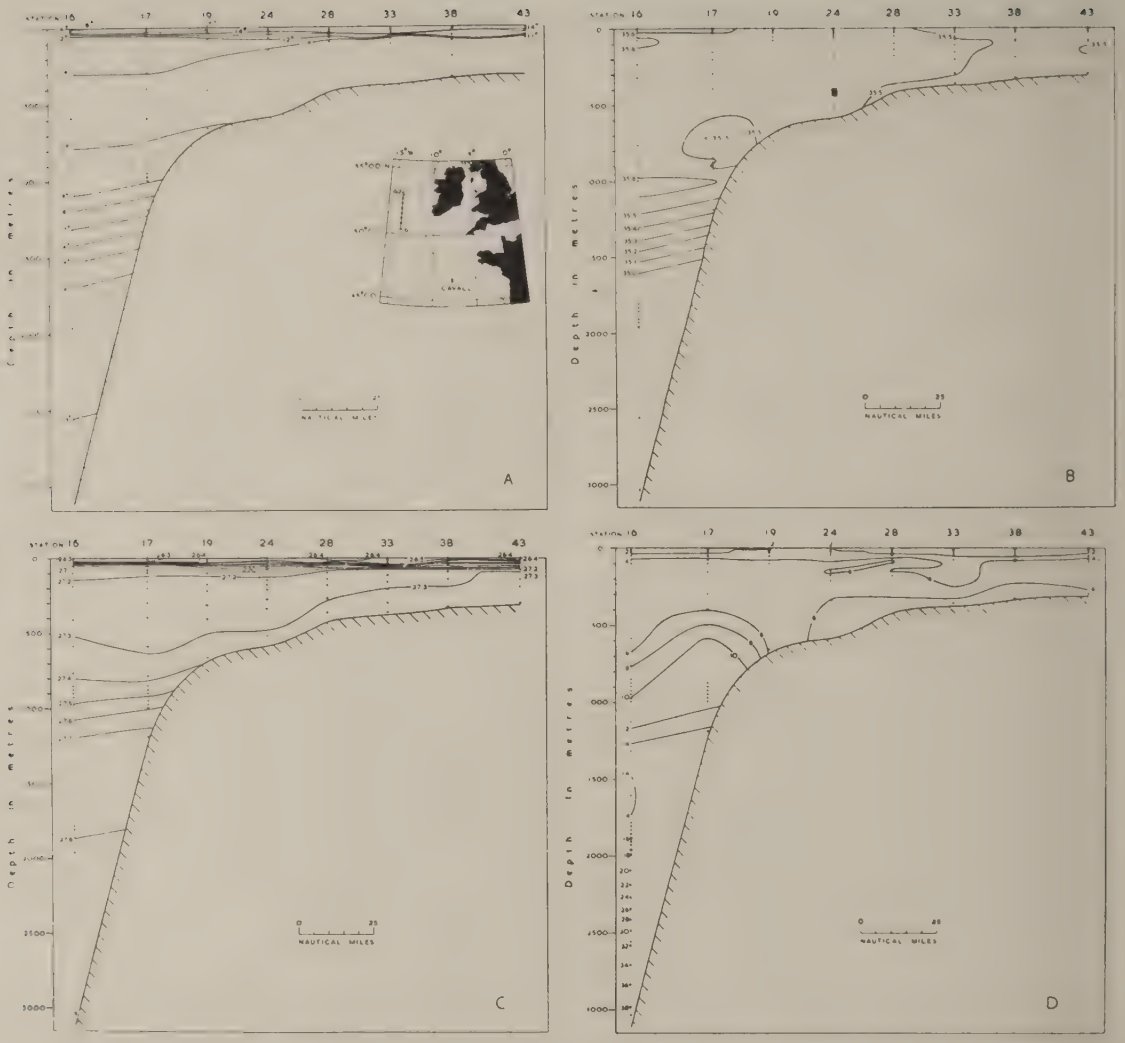


Figure 88. Section along the 14°W meridian south-west of Ireland, 3.—7. July 1960.
A = temperature (°C); B = salinity (‰); C = σ_t; D = silicate-silicon (µg-at./ litre).

tal slope and the current was strongest at the break in the continental slope. Between stations 24 and 19 the situation was not so clear cut and there is less sure indication of a bottom current, but between stations 19 and 17 there is a suggestion of a west-east current at all depths down to 657 m, where it was relatively strong, and probably down to 780 m, as the water at the more southerly station was lighter at all depths from 150 to 650 m, and the densities at 657 m at station 19 and 781 m at station 17 were identical. Turning now to stations 17 and 16, the trend of the isopycnals between these two stations suggests that down to 800 m the current was reversed and was flowing from east to west, but that below 800 m it was once again east-going, the density at 1186 m at station 17 being nearly the same as that at 1318 m at station 16. We would expect that water of northerly origin coming from the west would be colder and less saline than water with a larger component of Gibraltar water. If we compare the temperature and salinity values for surfaces of

Table 22. Excess of temperature (ΔT) and of salinity (ΔS) at station 16 compared with station 17 on equal σ_t surfaces

σ_t Surface	ΔT (°C)	ΔS (‰)
27.40	0.25	0.061
27.45	0.24	0.052
27.50	0.36	0.075
27.55	0.30	0.071

equal density at stations 16 and 17, as in Table 22, we find that this is so. Thus it seems reasonably certain that there was a bottom current in the bottom 300 m or so, covering the slope between stations 16 and 17, setting from west to east and bringing in a relatively cold and low salinity water compared with the Gibraltar type water at station 16.

Thus there is evidence that the whole slope down to 1100 m and maybe to 1900 m, except perhaps in the vicinity of station 19, was blanketed by an east-going current, which extended up to 100 m between stations 19 and 43. Earlier in the year, in March/May, the same distribution of mass could have been produced by cascading, but as our observations were made in July they should be free from this ambiguity. This current is part of one which follows the contours of the Porcupine Bank, at first flowing from north to south but turning to flow eastwards in the area where we have examined it. TULLOCH and TAIT (1959) on the basis of a survey made in June 1951 show a south-going current in the region of latitude 53°N, but their survey did not extend to our area. We have no

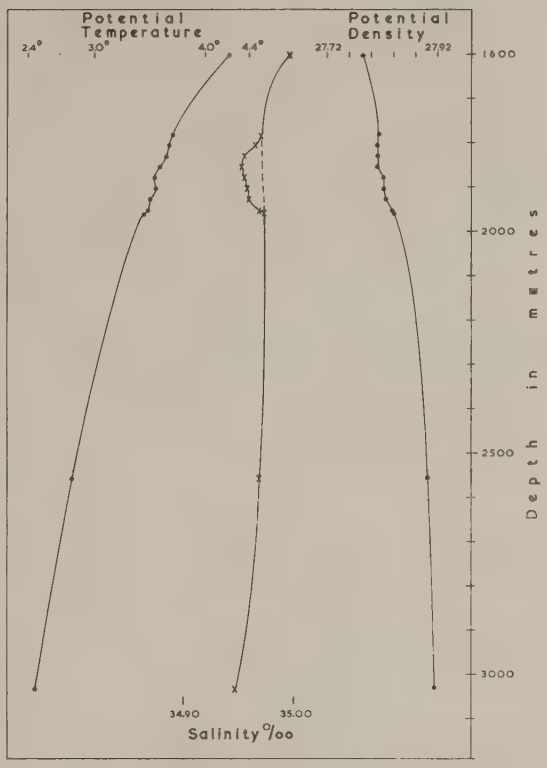


Figure 89. Station 16. Profiles of potential temperature, salinity, and potential density below 1600 m.

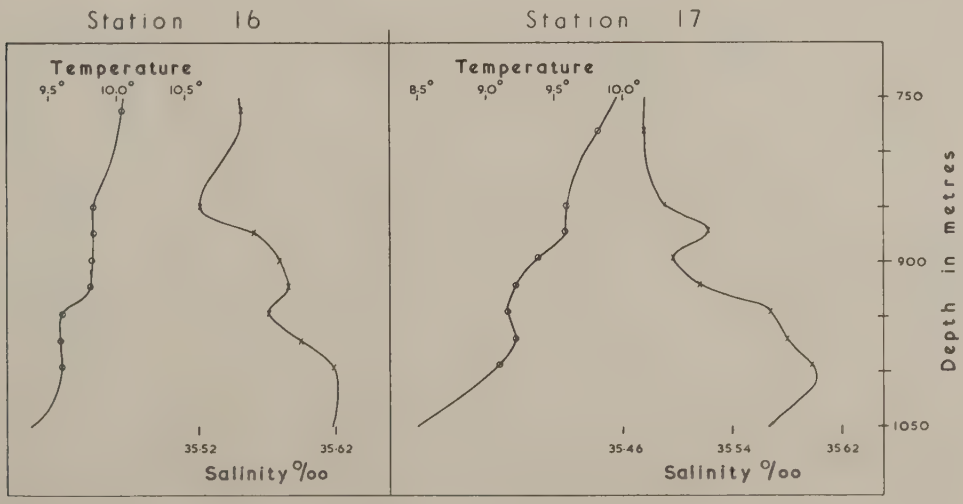


Figure 90. Stations 16 and 17. Profiles of temperature and salinity between 750 and 1050 m.

evidence that this current is a regular feature of the circulation south of the Porcupine Bank. Gibraltar water was moving west and north at 850 to 1100 m to seaward of the current when our section was worked. There was probably a lot of eddying between the two waters.

Finally, it must be pointed out that the conclusions reached here depend largely on the very accurate results obtained with the thermostat salinity meter built by the National Institute of Oceanography, Wormley. The blanket current along the slope and with it on the left has been observed by one of us (COOPER) several times before, but the accuracy of the salinity determinations makes this the most elegant demonstration of it so far.

L. H. N. COOPER, P. G. W. JONES, A. J. LEE

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Two Norwegian Cruises to the Coasts of West Africa

(Figures 91–93)

Owing to the great decline in the Atlanto-Scandian herring stock and in the Arcto-Norwegian cod stock, it has been necessary for the Norwegian fishery investigators to look for other possible means of employing the great surplus of Norwegian fishing vessels. On this background must be seen the

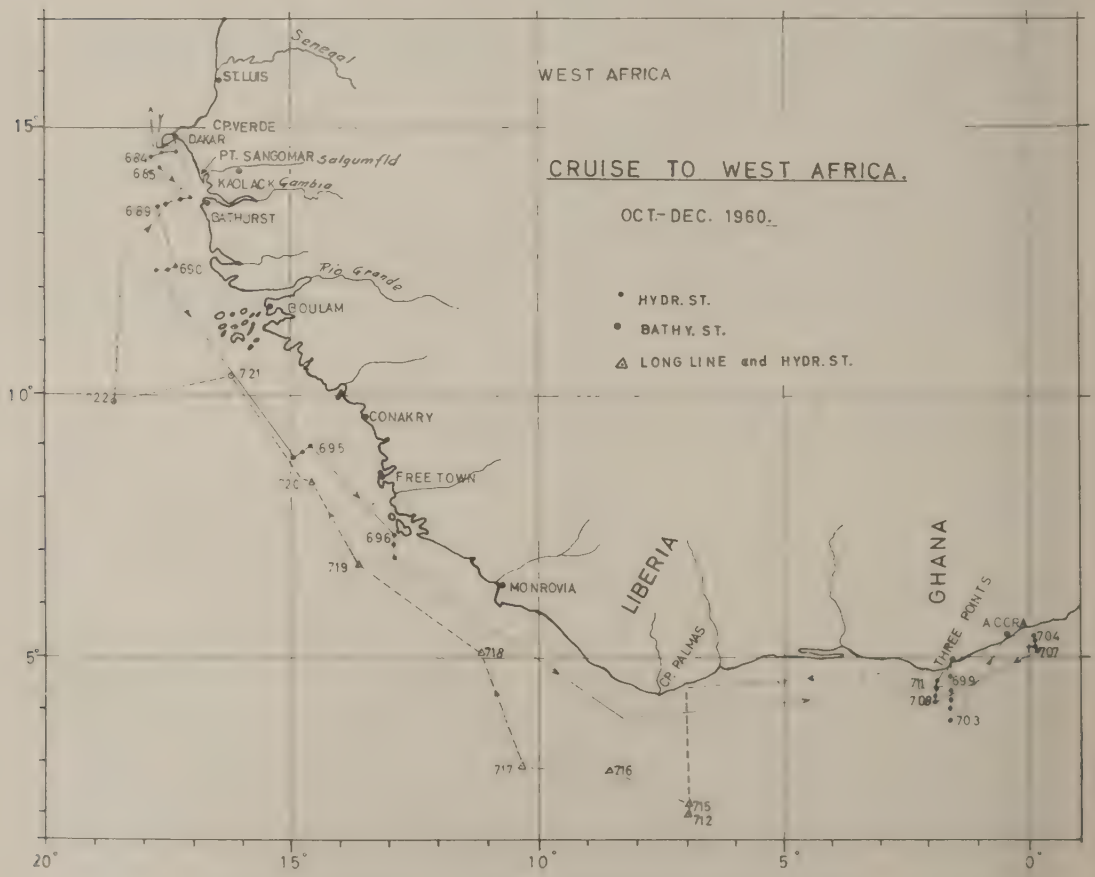

Figure 91.

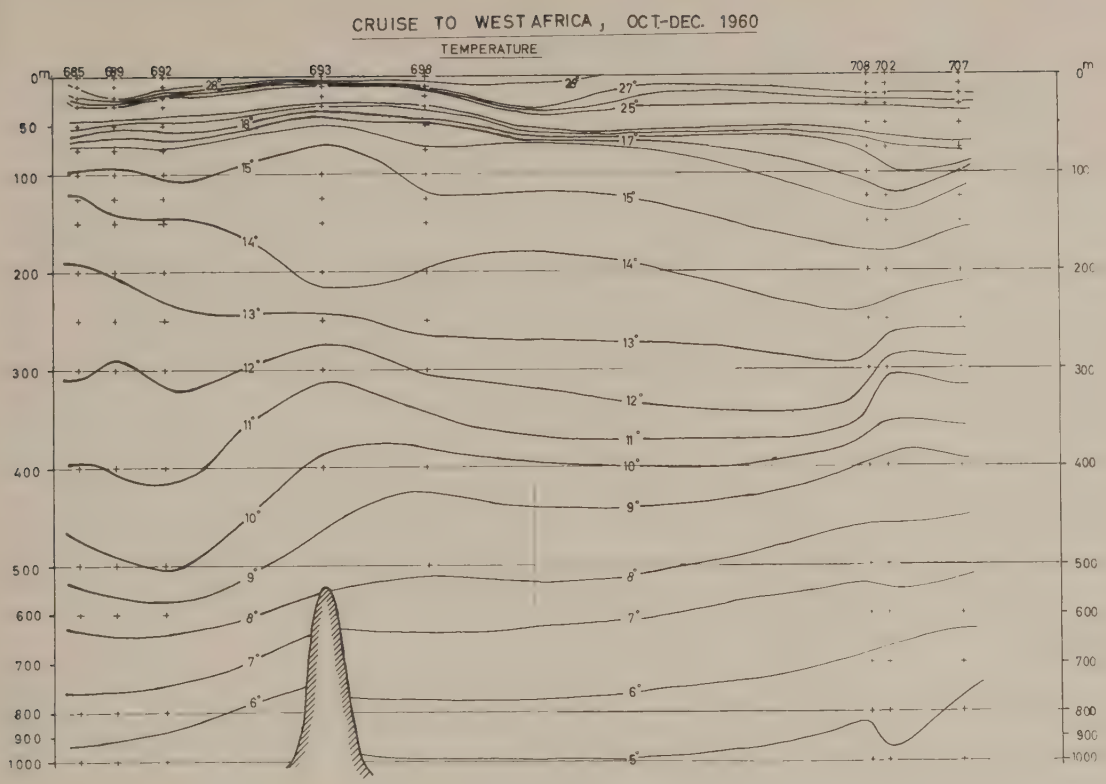

Figure 92.

initiative taken in starting fishery investigations off the coast of West Africa. It was primarily necessary to obtain first-hand information on the availability of fish off West Africa, and on the possibility of fishing there with the Norwegian type of ships.

A cruise was planned and carried out from the middle of October to the middle of December 1959. The research vessel was R. V. "Johan Hjort". On board were scientists specialized in hydrography, primary production, plankton, and ichthyology. The ship had a very efficient equipment of sonar instruments for locating concentrations of fish. A special report on the results of this expedition has been published in Norwegian (Fiskets Gang, 1960, No. 2).

The area investigated during the autumn of 1959 was from Gibraltar to Dakar, Senegal. Hydrographic sections were taken across the continental shelf. It is quite obvious that the short time at disposal for this cruise only could give a general view of the conditions at this season of the year. The concentrations of fish north of the Canary Islands were obviously smaller than those usually occurring in the North Sea.

South of the Canary Islands the conditions were far better. Especially the area between Port Etienne and Dakar looked promising. Both the primary production, the quantities of plankton and fish concentrations here seemed to be very good.

A second cruise was carried out between 1. October and 15. December 1960. The area of investigation this time included the continental shelf from Dakar to Ghana and adjacent waters. The research ship also mapped the concentrations of tuna and relayed the information to 7 Norwegian fishing vessels operating in the area which delivered their catches to a refrigerated transport vessel.

The map (Figure 91) shows the working stations and the route of the R. V. "Johan Hjort". The investigations were started off Dakar on 17. October. Hydrographic sections were taken across the shelf at strategic points. Asdic and echo-sounders were steadily in use in order to get an idea of the concentrations of fish. Especially in the region off

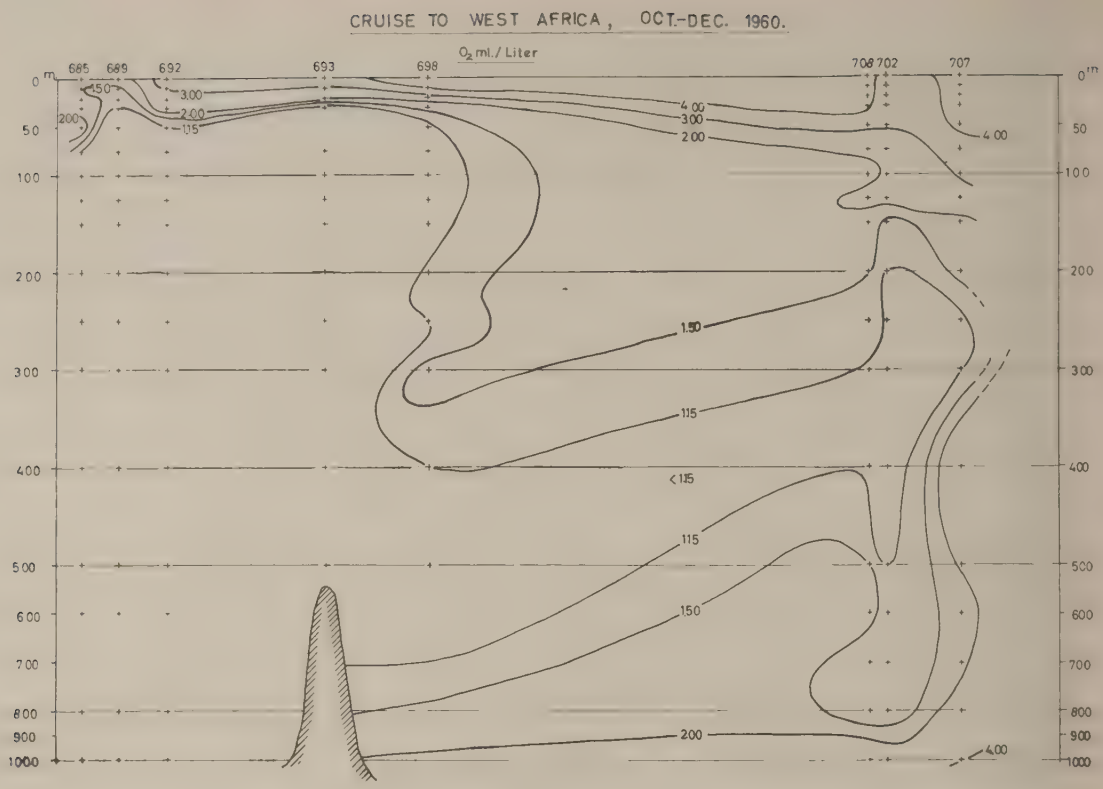

Figure 93.

Cape Three Points in Ghana large schools of yellowfin tuna were located during the first half of November. Two American tuna vessels had excellent fishing in this area. However, when the Norwegian fishing vessels arrived on 14. November the tuna schools had disappeared from this area. The Norwegian ships were fitted with purse-seiners and floating long-lines. The purse-seiners were originally constructed for cod seining in Norway, but they proved unsuitable for catching such a fastmoving fish as tuna. Also the experiments with long-lines resulted in poor catches, and the Norwegians could not compete with the Japanese long-line fishermen operating in the same area. The Japanese boats had a longer range, had faster power gurdies for hauling the lines and also greater freezing capacity. From an economic point of view the Norwegian fishing experiment must be said to be a failure.

The temperature conditions in the area between Dakar (Senegal) and Tema (Ghana) are illustrated in Figure 92. As will appear from the figure, there is a very pronounced thermocline all along this coast. Figure 93 illustrates the oxygen content in the same area. The figure shows that the oxygen content below the thermocline is very low. This condition may be seasonal as the sections were taken just after the rainy season. The lack of oxygen in the deeper layers apparently concentrate the fish schools in the surface layers. The many schools of tuna and other pelagic species observed in the surface may give the impression of greater fish resources than those really present. This is an important point which should be more closely studied by research vessels working in the area.

FINN DEVOLD

PART II.

PLANKTON AND BENTHOS

A. Distant Northern Seas

Plankton Investigations in the Barents Sea, 1960

Plankton observations were made in the periods April to July and in September 1960 in the Bear Island area, on the Finnmark Bank, the Nordkin Bank, in the Norwegian Gully, and in the Murman Tongue area, along the Kola Meridian and eastward up to 40°E.

Phytoplankton

Both in 1960 and 1959, the spring outburst of phytoplankton was observed in the Barents Sea in the month of April. *Halosphaera viridis*, *Thalassiothrix longissima*, *Coscinodiscus* sp., and *Ceratium* sp. appeared frequently in the coastal and central areas in April.

Large numbers of *Phaeocystis pouchetii* were observed on the section between the North Cape and Bear Island, on the Finnmark Bank, and in the Murman Tongue area. *Chaetoceros* sp., *Cosinodiscus* sp., and *Peridinium* sp. were encountered on the Demidov Bank and in the Central Elevation area. *Thalassiothrix longissima* was in progress in June near Bear Island. In July traces of phytoplankton were observed on the Kola Meridian (33°30′E) and eastwards.

Zooplankton

Eggs, nauplii, and mature *Calanus finmarchicus* prevailed in the samples collected east of the Kola Meridian in mid-April. In the coastal waters ova were numerous, together with nauplii of Euphausiacea and Cirripedia. The main components of the plankton in spring and summer were *Calanus finmarchicus*, *Pseudocalanus elongatus*, *Microcalanus pusillus*, *Metridia* spp., and *Oithona similis*.

In the North Cape/Bear Island area young *Calanus finmarchicus* (copepodite stage I) were abundant in May; nauplii and females of this species were still present. In 1960 the spawning of *Calanus* in that area was apparently prolonged. This might be due to the lack of phytoplankton organisms, as these nutrients to a great extent had been utilized by the numerous *Phaeocystis pouchetii* which species is inedible for *Calanus*.

Large concentrations of *Calanus* (stages I, II, and III) were encountered on the Kola Meridian (33°30′E) at the end of May and the beginning of June.

In July/August *Calanus*, having reached copepodite stages IV—V, began to descend and by September the bulk had disappeared.

In the Bear Island area and on the Finnmark Bank *Beroë cucumis* and *Aglantha digitale* were observed. *Oikopleura* and *Fritillaria borealis* were found in large numbers in the Norwegian Gully and on the Nordkin and Finnmark Banks.

It is noteworthy that in 1960 the warm-water organisms *Collozoum* and *Limacina retroversa* were widely distributed in the area investigated.

A. A. Degtjarjova

Soviet Plankton Investigations in the Norwegian Sea, 1960

The observations were carried out during the period March to October 1960. The standard sections along 63°N, 65°45′N, and 69°20′N were taken. A plankton survey from the Iceland-Faroe Ridge northwards to 78°N was accomplished in June. The results of that survey were reported at the meeting in Seydisfjord (Iceland) of scientists from Norway, Iceland, Faroe, and the USSR.

In April/May examination of plankton from the eastern areas was performed in order to elucidate its value as food for herring larvae. In the period April to September, plankton from the western and south-western areas of the Norwegian Sea was examined with a view to its value as food for herring.

Contrary to previous years (1950/1959) the development of plankton was not delayed in 1960 in the mixed waters of the East Icelandic Current, as compared with the eastern areas of the Norwegian Sea. In the latter areas, near the Lofotens, the development of plankton usually starts at the end of March or in April, and in the mixed waters of the East Icelandic Current it begins in June/July.

In conjunction with the increasing influx of warm water along the western branch of the Norwegian Current, the spawning of *Calanus* in the Faroe area was in 1960 observed in April, i. e., at the same time as in the eastern regions near the Lofotens. In previous years spent herring migrating from the Norwegian coastal waters westwards to the Faroes found there pre-spawning concentrations of adult *Calanus finmarchicus* and Euphausiacea; in waters with lower temperatures there were *Calanus hyperboreus*. In 1960 the spawning of these organisms took place rather early near the Faroes and by April it was over. As a result, the herring migrating into that area in April did not find large and adult crustaceans there; larvae and nauplii,

however, were abundant, but, due to their small size, they were useless as food for herring. In 1960 herring fed mainly on the young stages of *Calanus finmarchicus*, which appeared in May in the mixed waters along the edge of the East Icelandic Current. The fattening of herring on red *Calanus* continued in the areas to the north of the Faroes and Iceland in June/July.

In the eastern part of the Norwegian Sea the medusa *Aglantha digitalis* was abundant in June/July with a spread northwards up to 76°30′N.

In the northern part of the Norwegian and Greenland Seas *Calanus finmarchicus*, *Calanus hyperboreus*, and *Themisto abyssorum* were abundant in June 1960. But there were no herring. They were feeding in the area of the western edge of the East Icelandic Current moving slowly from Iceland to Jan Mayen. In 1960 herring reached their maximum fat content in June/July due to their feeding on red *Calanus*. In the previous colder years the feeding period was of much longer duration. In 1959 the herring reached their highest fat content in May/August and in the cold year of 1958 — first in August/September.

E. A. Pavshtiks

Investigations from Aberdeen in 1960

Phytoplankton

Sampling in the Faroe-Shetland Channel in October 1959 showed a continuance of the divided distribution of the oceanic plankton as seen in the summer and referred to in the previous year's report. Phytoplankton in the Faroe-Shetland Channel was very poorly represented until May when the spring outburst occurred with mainly *Thalassiothrix nitzschioides*, *Nitzschia seriata*, and *Chaetoceros*. West of Faroe *Rhizosolenia styliformis* was abundant in June, but by August the whole flora had been replaced by *Rhizosolenia alata* with *Chaetoceros debilis* in the open waters. By September *Thalassiothrix longissima* and *Nitzschia delicatissima* were the dominant forms.

Very little of the flora at the western entrance to the Faroe-Shetland Channel appeared to penetrate to the eastern end and conditions seemed fairly stable. Some phytoplanktonic evidence suggests a flow of oceanic water to the west of Faroe.

T. Lovegrove

Zooplankton

The summer oceanic zooplankton in 1959 at the western entrance to the Faroe-Shetland Channel, on a line between the Butt of Lewis and Faroe Bank, and reported last year, continued throughout the autumn and winter. It contained many Lusitanian species including the siphonophores *Vogtia pentacantha*, *Rosacea cymbiformis*, *Eudoxoides spiralis*, *Lensia fowleri*, *Hippopodius*, and also *Stylocheiron longicorne*, *Tomopteris krampi*, and *Clio cuspidata*. Of those of special interest is the record of *Enneagonum hyalinum* from the surface at 59°44′N, 7°15′W on 12. January 1960; this species is fairly common in the Meditraneeran but has not previously been recorded further north than 39°55′N, off the coast of Portugal. This fauna continued through the Faroe-Shetland Channel, covering the Nolsø-Flugga line almost end to end in January; and although still present there in March and April it was much reduced.

No samples were taken in the south-western part of the Faroe-Shetland Channel in June, but further north and to the west of Faroe the plankton was rich in oceanic forms and poor in *Calanus* indicating a continuation between the oceanic fauna west of Scotland and west of Faroe.

In July conditions were more normal with the Lusitanian fauna more confined to the region near the Scottish shelf and the usual Atlantic species further north and on the Faroe Plateau. *Calanus* was still very sparse.

In September and October there was a renewal of the earlier conditions when a moderately homogeneous plankton extended from the west of Scotland to the Iceland-Faroe Ridge and Lusitanian species were found to the northern limit of sampling at 62°47′N, 10°00′W and 61°35½′N, 13°16′W, including the salp *Ihlea asymmetrica* and the siphonophores *Vogtia*, *Hippopodius*, *Rosacea plicata*, and *Lensia fowleri*. This fauna also penetrated the southern side of the Faroe-Shetland Channel but did not affect the area east of Faroe which contained boreal plankton.

A band of *Calanus* and *Spiratella* (*Limacina*) existed between the oceanic plankton and the Scottish shelf.

J. H. Fraser

Sebastes in Continuous Plankton Records in 1960

(Figures 1–2)

Sampling with Continuous Plankton Recorders, at a depth of 10 metres and at monthly intervals when possible, was continued in 1960 in the Iceland-Irminger Sea/Greenland area, with 'Z' records (from Iceland towards New York) now extending as far as the Newfoundland Banks. A chart showing the Edinburgh Oceanographic Laboratory's Plankton Recorder routes was shown in the *Annales Biologiques* for 1959 (Glover and Barnes, 1961, p. 76).

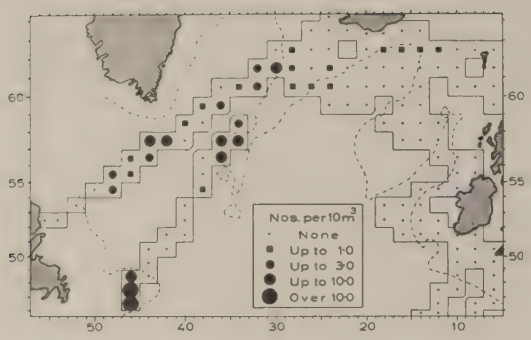

Figure 1. Chart showing the distribution of young *S. marinus* to the west of the British Isles in 1960. The months April to July are combined, and Recorder sampling to the east of 5°W Long., where *S. marinus* was absent, is not shown. The 1000 fathom depth contour is shown by a broken line.

Catches of young redfish again occurred in the months April to July, and as in previous years they all appeared to be *Sebastes marinus* (L.); none showed the subcaudal melanophores characteristic of the *mentella* type. The distribution in 1960 is shown in a single chart (Fig. 1) covering the four months: no 'Z' records were obtained in May or June, due to the diversion from this service of both the vessels then fitted for towing Plankton Recorders. As before, the results are expressed as the average numbers of young *S. marinus* per 10 m³ in statistical rectangles measuring 1° of latitude by 2° of longitude, and only those in which there were samples are enclosed by the outline of the sampled area. A small dot indicates the absence of young redfish.

Catches of *recently extruded* stages were taken in April and May, as in earlier years, mainly over the western slope of the Reykjanes Ridge. They occurred along the ridge as far as a position (about 57°N, 36°W) south-east of Cape Farewell (Greenland). There was a separate patch of these young stages east of the Newfoundland Banks, in the vicinity of Flemish Cap, which was sampled by the first full length April record obtained from this route. There were a few occurrences south-east of Iceland in May, on records taken between Faroe and Iceland on an alternative track not often sampled. In June the sampling was limited to two records south of Iceland, only one young stage being taken. In July, although none were taken south of Iceland, they were found in moderate numbers on a record between Iceland and the Strait of Belle Isle, the summer track for this route. Most were found in an area south of Cape Farewell, where they had also occurred on a record along the same route in July 1959, but some were taken in the Irminger Sea to the east of Cape Farewell.

The numbers taken in April and May over the western slope of the Reykjanes Ridge ranged up to 9 per 10 m³ sampled, not as numerous as at this period in 1957 or 1959, but the April patch near Flemish Cap showed maximum numbers of 24 per 10 m³, with 10 or more per 10 m³ in adjacent rectangles to north and south. The numbers taken in the Irminger Sea in July did not exceed 3 per 10 m³,

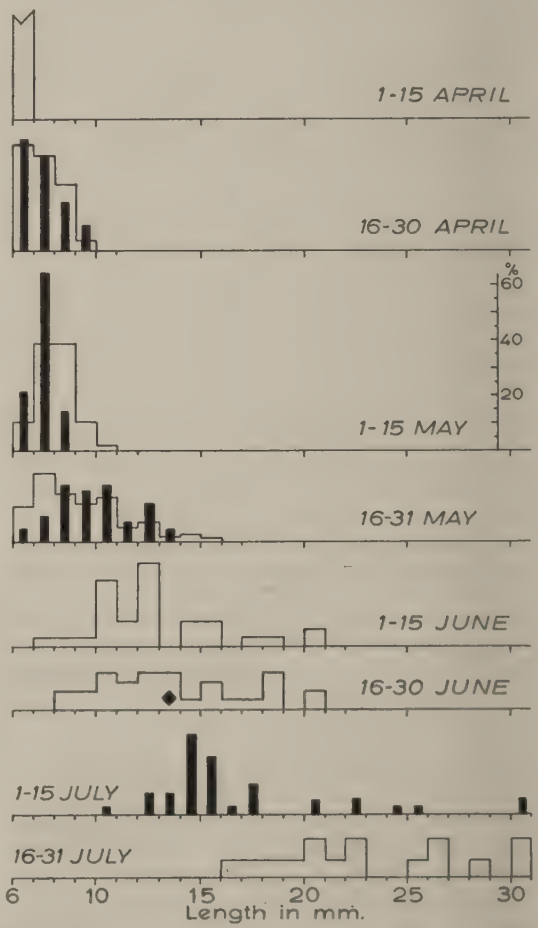

Figure 2. The percentage size-frequency composition of Recorder catches of young *S. marinus* in 1960 (blacked-in histograms) superimposed on that for the years 1955 to 1959 (open histograms). All specimens over 30 mm are included in the last size group on the base line. The single specimen taken in June 1960, is shown by a diamond. The scale is shown against the histograms for the first half of May.

but south of Cape Farewell attained a level of 10 per 10 m³. On the whole these young redfish appeared to be less abundant in 1960 than they had been in 1959, but in view of the unfortunate restriction of the sampling in May and June this assessment is of limited value.

In Figure 2 the size frequencies of the *S. marinus* taken in 1960 are compared with those for the years 1955 to 1959. Where there is material for comparison, there is general agreement between the frequencies in 1960 and in previous years, although the mean length was slightly greater in the second half of May 1960. The figures for the first half of July fill a gap in the earlier data and the size distribution is such that the suggestion made in the *Annales Biologiques* for 1959 (Henderson, 1961, p. 74) that the July catches south of Greenland might be a separate population now seems to have been premature: all eight sets of histograms seem to fit a common growth curve.

A full account of the young *Sebastes marinus* taken in the Recorder survey will be published in Volume V of the *Bulletins of Marine Ecology*.

G. T. D. Henderson

B. Near Northern Seas

Plankton Investigations from Aberdeen

(Figure 3)

Phytoplankton

Halosphaera was abundant in the northern North Sea, and westwards from Shetland to the Minch, during late autumn 1959, and it persisted until April with traces of oceanic species such as *Thalassicolla* and *Collozoum* during the winter months. There was very little general phytoplankton at that time but a small outbreak of *Thalassiothrix nitzschioides* was found in the Firth of Forth as early as December, and persisted until March when it was also found close to the Scottish east coast with *Coscinodiscus*, *Chaetoceros convolutus*, and *Ditylium*.

By April and May rich communities of *Skeletonema* with correspondingly high faecal pellet numbers were found in the Clyde.

Samples in the North Sea in June showed *Guinardia flaccida* to be dominant in a narrow coastal belt in the north-western area with *Ceratium fusus* further south, whilst in the central part was a mixed dinoflagellate community, and *C. macroceros* towards the Norwegian side. These dinoflagellates were associated with low numbers of diatoms but high numbers of faecal pellets and suggest that the dinoflagellates were occupying a space originally occupied by diatoms which had been grazed down.

Rhizosolenia alata, the typical summer diatom, dominated the Faroe-Shetland Channel and the northern North Sea from July to September, and penetrated the southern, but not the northern entrance to the Minch. It was not, however, found in such great numbers in 1960 as in previous years.

Halosphaera was again found in Shetland waters as early as September, and in the Faroe-Shetland Channel *Thalassiothrix nitzschioides* was found accompanied by *Noctiluca* which is unusual in this area.

The general impression is that the sequence of events in 1960 was much as usual, the spring outburst being slightly late, but numbers were much lower than usual.

Aberdeen Bay Station

Samples from Aberdeen Bay were taken by research vessels on entering and leaving Aberdeen during 1959 and 1960 and this is being continued in 1961. Figure 3 shows the annual sequence of the main phytoplankton species to date arranged monthly, each month being divided into four equal periods.

T. Lovegrove

Zooplankton

The year was characterized by a poor inflow of oceanic plankton into the northern North Sea by way of Shetland, although oceanic communities were abundantly evident at the western entrance to the Faroe-Shetland Channel (see Distant Northern Seas). There was however a marked inflow of mixed water from the shelf area between Orkney and the Scottish west coast and this gave good populations of *Calanus* in the Fair Isle region in April but their numbers elsewhere were distinctly below average. As the year proceeded little change was noted, and although the mixed fauna brought with it individuals of oceanic origin, such as *Rhincalanus*, *Eucalanus elongatus*, *E. crassus*, and *Sagitta serratodentata*, these were scattered and not in oceanic communities. They were found chiefly in the west of the northern North Sea and in the Moray Firth but extended as far south as 57°N.

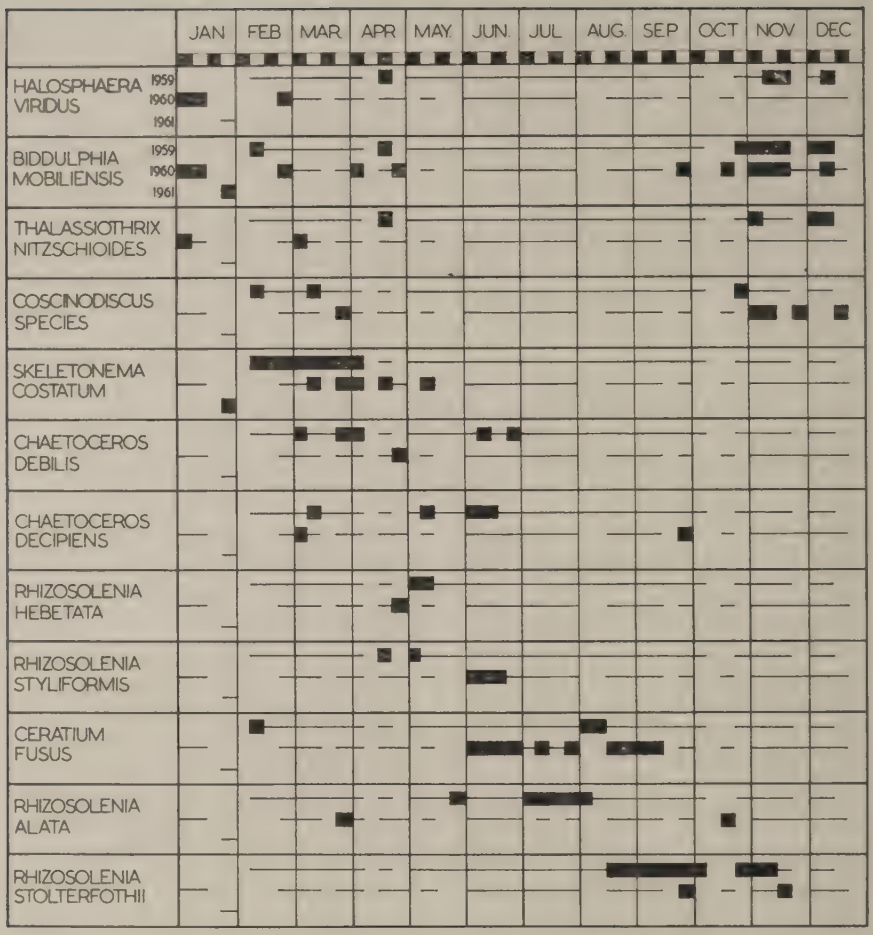

Figure 3. The sequence of phytoplankton in Aberdeen Bay, 1st January 1959—1st February 1961.

During the summer, conditions were ideal for the incursion and development of *Spiratella* (= *Limacina*) which in 1960 occurred in large concentrations from 56°N to the southern part of the Norwegian Sea. It was accompanied by the other pteropods *Clione* and *Pneumodermopsis* and the siphonophore *Apolemia uvaria*. *Calanus* remained scarce in the North Sea except near Fair Isle and east of 0° towards the Norwegian coast, and euphausids were also less numerous than usual though at times large quantities of furcillia stages were present in patches. West of Orkney, off the north coast of Scotland and in the Minch where mixed waters were present *Calanus* was quite numerous.

Sagitta setosa was found as far north as 61°N in April, and this species formed about 50% of the *Sagitta* population off the Berwick coast (55°N) in September; it was abundant at the same time to 58°30′N near the edge of the Norwegian Deep. There was some increase in the numbers of *Calanus* in September in the north-western North Sea but they did not reach high numbers. *Temora* was the most numerous of the smaller copepods especially in the Moray Firth.

Off the west coast of Scotland the oceanic influence was much more marked especially at the southern entrance to the Minch where a few salps and many doliolids were found in September.

Pleurobrachia, though present in 1960, did not reach their normal abundance.

J. H. Fraser

The Continous Plankton Recorder Survey: Plankton around the British Isles during 1960

(Figures 4—12)

The Plankton Recorder Survey was continued during 1960, on a similar scale to that of 1959, in the north-east Atlantic and the North Sea. The routes from which samples were collected (at monthly intervals, and from the standard depth of 10 m) are shown in the *Annales Biologiques* for 1959 (GLOVER and BARNES, 1961, p. 76, Fig. 7).

In previous years it has been the custom to present the results for the *Annales Biologiques* in the form of histograms showing the abundance of selected organisms, month-by-month, along selected routes in the north-eastern Atlantic and the northern North Sea. This technique has been modified for the present account of the plankton in 1960, and it is proposed to use this new method of presentation in future reports. The area covered by the monthly survey has been divided into a number of sub-areas designed to facilitate comparison of Plankton Recorder material with fishery statistics and hydrographic data. These sub-areas are shown in Figure 4. For each month, in each sub-area, the mean number per Recorder sample has been calculated for a number of selected organisms.

Details of the methods of analysis of zooplankton in Recorder samples have been provided by COLEBROOK, 1959[1]). Phytoplankton colour is assessed visually, in four categories according to the intensity of the green colour of the silks. The four standard categories have been assigned arbitrary numerical values based on comparisons of acetone extracts of typical Recorder samples.

For the routine treatment of the data, the area is divided into rectangles (2° Long. by 1° Lat.), each corresponding to four international squares. The counts of organisms in individual samples are transformed, using $y = \log_{10}(x + 1)$; the logarithmic mean number per sample is then calculated for each organism in each rectangle in each month. These rectangle means are averaged to provide, for each month, the mean number per sample in each of the sub-areas shown in Figure 4. These sub-area means are shown as histograms in Figures 5—12.

In order to provide a measure of the 'normal' seasonal cycle of each organism, long-term means have been calculated for each month in each sub-area. They were obtained by combining all the results obtained with Plankton Recorders during the years 1948—1959; the long-term means are shown as line graphs in Figures 5—12.

[1]) Bull. Mar. Ecol., 5: 51—64.

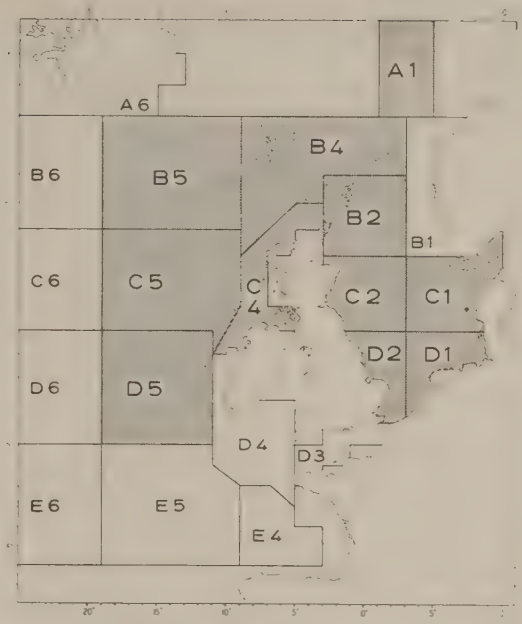

Figure 4. A chart showing the area sampled by Continuous Plankton Recorders during 1960. The area has been divided into sub-areas. The stippled sub-areas have been sampled regularly since 1948 and are the basis of the the results presented in Figures 5—12.

For the present report, results relating to sub-areas A6, B6, D4, and E5 have been omitted because sampling was available for only a part of the year in these sub-areas. Results from D3 and E4 are omitted because these sub-areas have been sampled by Recorders since 1957 only and long-term means cannot, therefore, be calculated. Results from B1 are omitted because the sampling is limited to the extreme north and south of this sub-area. The histograms are arranged in two groups in the figures which follow. Firstly, the oceanic areas, representing sampling over deep oceanic water from the most southerly (D5) to the most northerly (A1). Secondly, and separated in the figures from the oceanic areas by a heavy line, the continental shelf and North Sea areas, arranged in a counter-clockwise sequence round the British Isles from C4 to D1. Detailed results from all the areas, and from a route between Iceland and Newfoundland, will be supplied on application to the Officer-in-Charge, Oceanographic Laboratory, Craighall Road, Edinburgh 6, Scotland.

The green colour of the silks (Figure 5) showed that phytoplankton was less abundant than usual and the spring outburst was late in the areas over

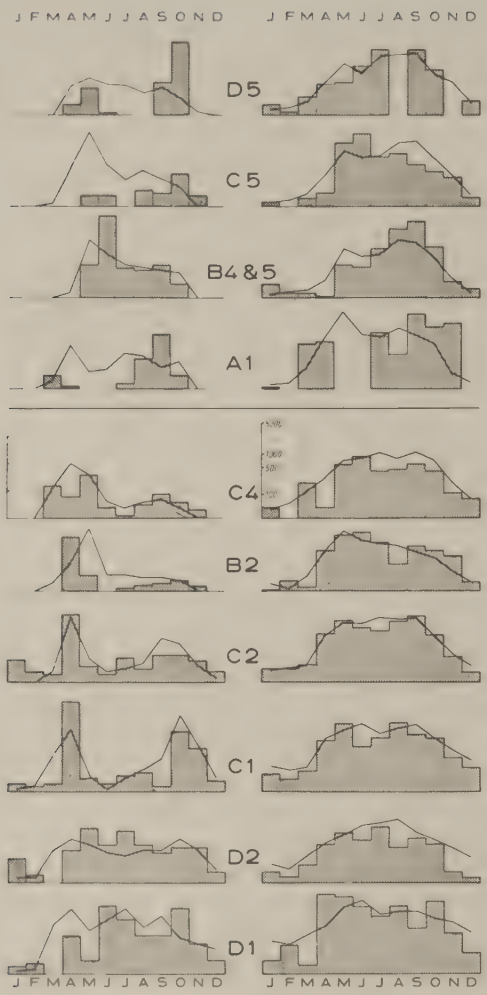

Figure 5 (left). Histograms showing a month-by-month estimate of the phytoplankton during 1960, based on visual assessments of the green colour of the Recorder silks converted to an arbitrary scale.

The letters and numbers (D5, etc.) refer to the sub-areas shown stippled in Figure 4. Results obtained over oceanic areas (D5, C5, B4 and 5, A1) are shown above the heavy line; below this line are results from the continental shelf and the North Sea (C4, B2, C2, C1, D2, D1). A break in the base-line indicates that there was no sampling in that month. The line graph shows the long-term mean value for the phytoplankton, based on a combination of all Records in each sub-area in the period 1948—1959.

Figure 6 (right). Histograms showing, month-by-month during 1960, the average number per Recorder sample of Total Copepods in the sub-areas shown in Figure 4. A Recorder sample represents the plankton in about 3 m^3 of water (see Figure 5 for further details).

the deep Atlantic (D5, C5, B4 and 5, A1). This appeared to be explained partly by unusually low numbers of *Chaetoceros* spp. in these areas. In June there was a rich crop of phytoplankton between Scotland and Iceland (B4 and 5) with *Nitzschia delicatissima* dominant. But, with this exception, the peaks in phytoplankton numbers came late in the year in the oceanic areas (September and October when *Nitzschia delicatissima*, *Thalassionema nitzschioides*, *Ceratium fusus*, and *C. furca* were abundant).

In the North Sea and over the continental shelf the spring outburst of phytoplankton, as usual, was about a month earlier than in the Atlantic and green colouration was evident throughout the year at values close to the long-term average. *Rhizosolenia alata alata* was abundant in the northern North Sea (C1 and C2) in July and August but *R. styliformis* was unusually scarce in the southern North Sea (D1 and D2). *Thalassiothrix longissima* was absent from Recorder collections in the North Sea for the first time since 1951, although it was extremely scarce in 1959. It is interesting to compare this with the copepod *Corycaeus anglicus*, which disappeared from Recorder samples in the southern North Sea in 1951, the year when *T. longissima* first occurred. *Corycaeus* reappeared in the southern North Sea during the winter of 1959—60, when *T. longissima* disappeared.

The numbers of Total Copepods (Figure 6) were close to the average in most areas. The most striking departure from the long-term average being in the last quarter of the year in the Norwegian Sea (A1) where the unusually large numbers of copepods consisted of *Acartia clausi* and *Pseudocalanus elongatus*. Over the deep Atlantic (B4 and 5, C5, and D5) the numbers of *Pseudocalanus elongatus* and *Calanus* (Figures 7 and 8) were well below average but the numbers ot Total Copepods were maintained by unusually large numbers of *Acartia clausi* (the largest recorded during the period 1948 to 1960, the peak abundance occurring in July, about a month earlier than usual). In the areas C5 and D5 the numbers of *Pseudocalanus* were the lowest recorded during the period 1948—1960, and in B4 and 5 lower numbers were found only in 1954 of which RAE (see Ann. Biol., **11**: 54—58) wrote, "taking the copepods as a whole, 1954 was an extremely poor season ... the average figures were lower than during any of the previous six years." As always, *Calanus* (Figures 7 and 8) was most abundant in the Norwegian Sea, especially in March, April, and July; unfortunately there was no sampling in this area (A1) in May and June.

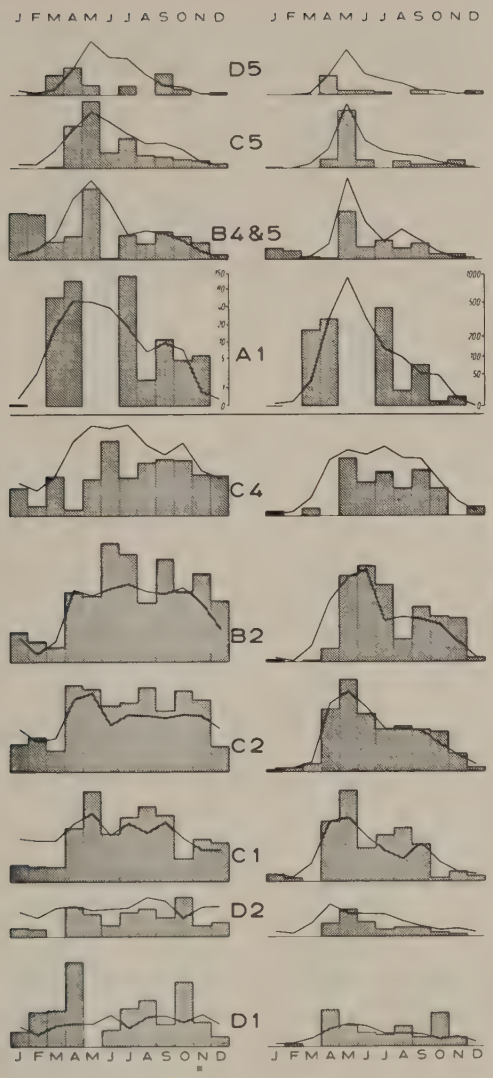

Figure 7 (left). Histograms showing, month-by-month during 1960, the average number of copepodite stages V and VI of *Calanus* (for details, see Figures 5 and 6). The *finmarchicus* and *helgolandicus* forms are combined in this illustration and in Figure 8.

Figure 8 (right). Histograms showing, month-by-month during 1960, the average number of all stages of *Calanus* (for details, see Figures 5 and 6).

The results for *Metridia lucens* (Figure 9) are based on sampling by night only; this species, which carries out extensive vertical migrations, is relatively rare in Recorder samples taken by day. Like the phytoplankton and *Calanus*, numbers of *Metridia* were below average during 1960 in the Atlantic but close to or above average in the North Sea. *Metridia* was especially abundant in the Norwegian Sea in the autumn, and over the continental shelf to the west of the British Isles during the last two months of the year.

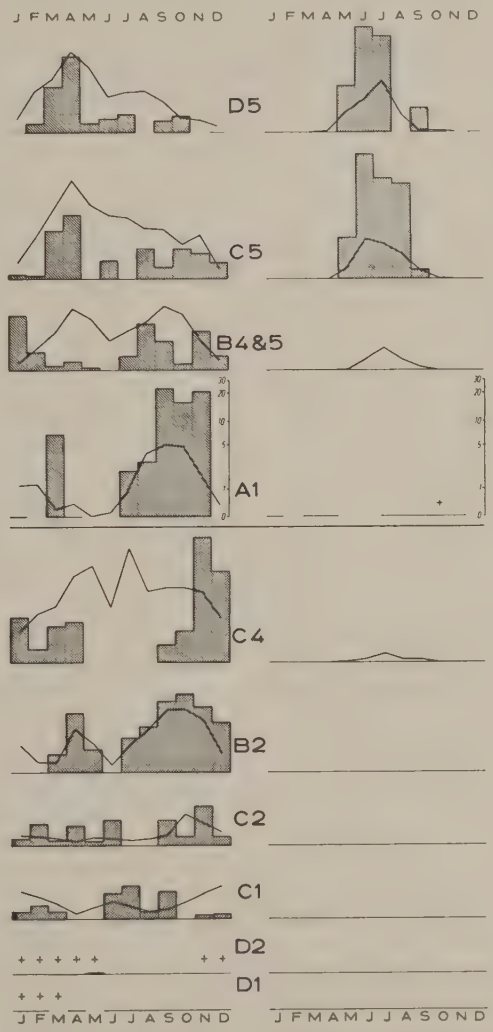

Figure 9 (left). Histograms showing, month-by-month during 1960, the average number of *Metridia lucens* in samples taken by night (for details, see Figs. 5 and 6). Crosses indicate months and areas in which *Metridia* occurred in small numbers during the period 1948—1959.

Figure 10 (right). Histograms showing, month-by-month during 1960, the average number of *Dolioletta* (*Doliolum*) *gegenbauri* (for details, see Figures 5, 6, and 9).

Dolioletta (*Doliolum*) *gegenbauri* (Figure 10) and *Thalia* (*Salpa*) *democratica* were much more abundant than usual in the oceanic areas C5 and D5 where they were found with *Salpa fusiformis* which was less numerous than usual. But none of these species were found further north in the Atlantic, over the continental shelf, or in the North Sea where *D. gegenbauri* and *S. fusiformis* have sometimes been found in years when Atlantic inflow has been thought to have been strong. *Iasis* (*Salpa*) *zonaria* was found in area E5 in April but absent from D5 where it has occurred frequently in the past. *Ihlea asymmetrica* (usually present in areas A1, B4, B5, and C5) was absent from Recorder samples throughout 1960.

Spiratella (*Limacina*) *retroversa* and *Clione limacina* (Figures 11 and 12) provide the most striking examples of species which were much less abundant than usual over the deep oceanic waters of the Atlantic, and much more abundant than usual over the continental shelf and the northern North Sea. This represents a change in the distribution of these species which became evident in the period 1952—1956 when their centre of distribution shifted from oceanic waters to the continental shelf and the northern North Sea.

The most striking feature of the plankton in 1960 was the appearance of the pteropod *Pneumodermopsis paucidens* in Recorder samples over the continental shelf (C4) and, in large numbers, in collections taken with Plankton Indicators in the north-western North Sea (B2 and C2) where it became much more abundant than *Clione* in September and October. This is the first time *P. paucidens* has been recorded from the North Sea. Its normal distribution is restricted to the Atlantic, and, particularly, the waters of the continental shelf off the Scottish and Irish west coasts. Its appearance in the North Sea during the period July—December coincided with small numbers of *Euchaeta hebes*, *Eucalanus crassus*, and *Pleuromamma borealis*. The first two of these copepods were found in the same areas (B2 and C2) in 1959; all three are normally absent or rare in Recorder and Indicator collections in the North Sea. Although *P. borealis* and *E. crassus* are normally considered to be 'oceanic', they were found also in shelf waters (C4) in Recorder collections in 1960.

During the second half of 1960, therefore, the plankton of the north-western North Sea contained a group of organisms which were limited to this area and the shallow waters of the continental shelf. Many of these species, in the past, have been considered as typical of more oceanic water to the west of the continental shelf. The plankton of the north-western North Sea has always had many features in common with the shelf waters to the west of the British Isles but the impression gained from Recorder sampling is that the two communities have become progressively less distinguishable during the past eight years or so. The list of cha-

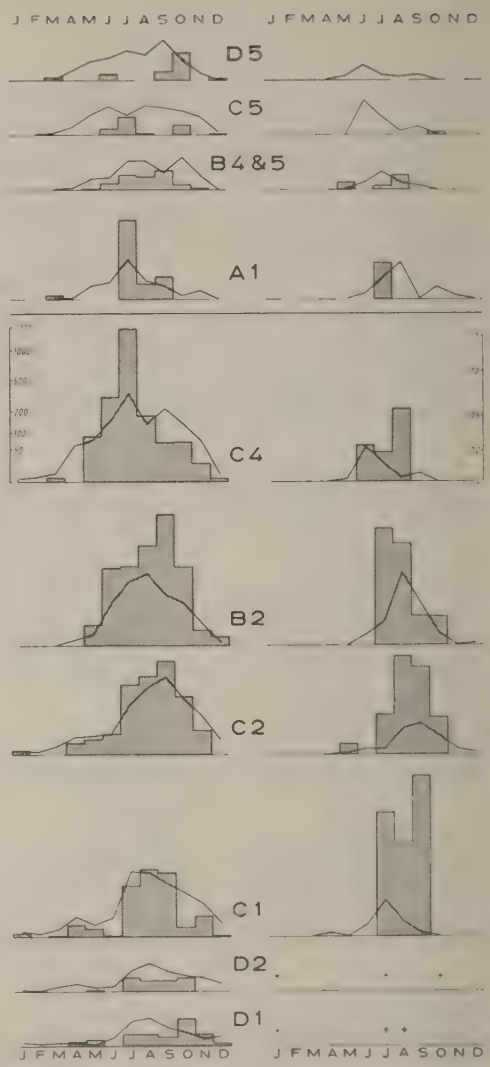

Figure 11 (left). Histograms showing, month-by-month during 1960, the average number of *Spiratella* (*Limacina*) *retroversa* (for details, see Figures 5 and 6).

Figure 12 (right). Histograms showing, month-by-month during 1960, the average number of *Clione limacina* (for details, see Figures 5 and 6). Crosses indicate months and areas in which *Clione* occurred in small numbers during the period 1948—1959.

racteristic species in the Recorder and Plankton Indicator collections from the north-western North Sea in 1959 was not unlike that for the second half of 1960 which included *Spiratella retroversa, Clione limacina, Pneumodermopsis paucidens, Euchaeta hebes, Eucalanus crassus, Rhincalanus nasutus, Pleuromamma borealis, Candacia armata, Centropages typicus, Metridia lucens,* and *Sagitta elegans. Ceratium* spp., which were present in relatively low numbers in the North Sea in 1960, are never abundant in Atlantic coastal waters.

It must be concluded that there was no evidence, from the plankton in 1960, of oceanic incursion into the northern North Sea where the plankton was characterized by typical Atlantic shelf and coastal species although there is no direct evidence to show whether this was the result of coastal inflow or of the biological similarity of the northern North Sea and the continental shelf.

R. S. Glover, J. M. Colebrook,
and G. A. Robinson

C. Baltic-Belt Seas

The Quantity of Planktonic Microbiomass and Detritus in the Kiel Bay, 1960

(Tables 1–2)

In order to get an impression of the changes in the quantity of planktonic biomass during a full year as well as from one year to another, analyses were carried out at a station in the Kiel Bight (Boknis Eck, 54°31′N, 10°03′E). This biomass, consisting of phyto- and zooplankton, forms the basis of nutrition for all filter-feeding animals both in the pelagial and in the deeps. The analyses were performed by chemical methods and were partly controlled by microscopical observations. The microbiomass is estimated as dry weight in g/m² from the values for albumen multiplied by a factor. This factor is 6.0 for plankton consisting mainly of diatoms, a factor of 3.0 for dinoflagellates, and of 2.4 for mixed plankton (see Hagmeier, Kieler Meeresforsch., *17*, 1961). Due to the active and passive vertical migration the IMK-values were estimated from the original observations at 0.5, 5, 10, 15, 20, and 26 m depth at Boknis Eck. Table 1 gives the average values for 1958/60 and the values for each month of 1960. The yearly mean value for 1958 was 7.2 g/m² (dry weight); for 1959, 7.4 g/m²; and for 1960, 10.1 g/m².

These means are closely connected with the increase in the means of salinity and total phosphorus at Boknis Eck. In this special area a relation with the prevailing eastern winds is likely to exist.

Analyses of the contents of detritus were made in close connection with those of biomass. The results are shown in Table 2. The mean value for 1958 was 19.0 g detritus/m² (dry weight); for 1959 it was 25.5 g/m², and for 1960 37.7 g/m².

The detritus values given in Table 2 are estimated by the difference between the dry weight of seston and the dry weight of the organic substances. As the content of organic matter in detritus is very variable a close relation between the single samples and the living substances cannot be expected.

For all observations the particulate matter consists on an average of 73% detritus and 27% organic material.

Table 1. Planktonic microbiomass at station Boknis Eck (Kiel Bay) in g/m²

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Average 1958/60	4.9	6.5	18.1	26.7	8.5	5.2	2.8	6.2	6.2	6.9	3.6	5.8
1960	6.6	8.9	20.1	31.4	3.7	5.6	3.8	7.1	8.3	7.4	4.4	6.6

Table 2. Planktonic detritus at station Boknis Eck in g/m²

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Average 1958/60	44.0	24.0	45.0	28.4	20.6	15.1	24.7	9.6	20.0	20.0	18.2	37.0
1960	80.5	25.0	61.0	13.3	53.5	14.3	16.9	1.8	13.5	17.4	33.6	54.4

J. Krey

Macroplankton as Indicator of Saline Influx of North Sea Waters into the Baltic

(Table 3)

The brackish character of the Baltic is maintained by inflow of salt North Sea waters. These waters bring in large amounts of plankton species which are unfamiliar to the Baltic. In the current century, 15 species were encountered of macroplankton only. Among these were species which appeared only once, and others which were met frequently or even very frequently. The appearance of these "guests" was particularly frequent in the period 1948 to 1960 (see Table 3), that is, the period in which very intensive Polish investigations were carried out in the southern Baltic. The presence among the Baltic plankton species of those presented in Table 3 gives evidence of an influx of North Sea water during that period, without the necessity of carrying out salinity analyses. Owing to this fact these species have been termed "biological indicators of inflow".

Among these "biological indicators" the medusa *Melicertum octocostatum* deserves special attention. It became a constant component of the Baltic macroplankton for a period of seven years from 1949 to 1955. The salinity conditions when *Melicertum octocostatum* first appeared, those prevailing during its whole stay, and those during which it disappeared from the plankton have been carefully analysed. During the presence of this species the salinity of the water layers in which it lived was always higher than 16‰.

W. Mankowski

Table 3.

Species

Year	*Sarsia tubulosa*	*Hybocodon prolifer*	*Rathkea octopunctata*	*Catablema vesicarium*	*Phialidium hemisphericum*	*Melicertum octocostatum*	*Steenstrupia nutans*	*Tomopteris helgolandica*	*Calanus finmarchicus*	*Eupagurus bernhardus* (Zoëa)	*Macropsis slabberi*	*Limacina retroversa*	*Sagitta setosa*	*Sagitta elegans elegans*	*Oikopleura dioica*
1903															+
1904				+								+			+
1905	+														+
1907															+
1908		+													
1923	+		+												
1931	+					+			+						
1933	+	+	+							+					
1948					+				+				+		+
1949					+	+			+		+		+		
1950						+			+		+		+		+
1951	+		+			+			+		+			+	+
1952						+			+		+		+	+	+
1953					+	+			+	+			+		+
1954	+		+		+	+	+		+				+		+
1955						+			+				+		
1956									+				+	+	+
1957	+										+		+		
1958									+				+		
1959								+	+				+		+
1960	+	+	+						+				+	+	

Phytoplankton in the Firth of Szczecin (Stettin)

On the basis of the material collected in 1960 it was stated that the development of phytoplankton differed from that of former years, particularly so in the autumn. In former years (investigations have been conducted since 1955), a certain regularity could be observed in the appearance of some species in certain seasons of the year. In the spring and early summer of the years 1955/59 the following diatom species were successively predominant: *Asterionella formosa et gracillima*, *Melosira granulata*, and *Diatoma elongatum*. Apart from these diatoms, Chlorophyceae constituted a considerable admixture, mainly *Scenedesmus* and *Pediastrum*. After the summer minimum which generally takes place in July, *Melosira granulata* again became abundant with a maximum in the first half of August; at the same time a rapid development of *Aphanizomenon flos aquae* was noted. The predominance of this species over the remaining plankton components has always been very distinct in this period and sometimes it has even been the sole plankton component (1955). The above data concern the northern and middle part of the firth proper.

During the spring of 1960, two diatom species were abundant in the area mentioned; they were *Diatoma elongatum* and *Asterionella formosa* and they were present up to the end of May. *Melosira granulata* and *Melosira varians* were predominant at the end of May and the beginning of June. A rapid development of *Microcystis aeruginosa* took place from June. Similar to former years the summer minimum took place in July. In former years Chlorophyceae constituted the main phytoplankton component in this period. In July 1960, however, *Microcystis aeruginosa* with an admixture of *Melosira granulata* and *Sceletonema subsalsum* were the species most frequently encountered. After the minimum period, *Microcystis aeruginosa* intensified its growth and by autumn it was still the dominant form; on the other hand, *Aphanizomenon flos aquae* was less numerously represented.

A rather rapid drop in quantity and activity of the phytoplankton was noted from October. In that month it was mainly composed of dead and decomposing colonies of *Microcystis* and *Aphanizomenon*. Only *Sceletonema subsalsum* and *Coscinodiscus Rothii* as well as *Scenedesmus* (the latter in rather small numbers) were fully active.

In the southern part of the Firth of Szczecin and the Odra Roztoka the development of phytoplankton had a different course from that of the waters described above. Through the entire period of investigation in 1960, *Melosira granulata*, accompanied by *Sceletonema subsalsum* and *Melosira varians*, were predominant here.

Apart from the dominant species a considerable number of accompanying species is usually present. In former years they were plentiful and the frequency of some deserve attention. In 1960 however, the period of investigation was characterized by the small number of accompanying species and their slight abundance.

The difference between the development of phytoplankton in 1960 compared with former years are most likely ascribed to the climatic conditions of that year, which was characterized by a great number of cloudy and stormy days and a low temperature of the water throughout the whole vegetation period. The temperatures during the warmest months (July, August) did not exceed 20°C while the temperatures in former years for these months were about 21°—22°C.

D. Zembrzuska

The Mysid *Praunus inermis* (Rathke) in Puck Bay

Up to the present, only the following mysids have been enumerated in the scientific publications as occurring in the coastal waters of the southeastern Baltic: *Neomysis vulgaris* (Thompson), *Praunus flexuosus* (Müller), and, at somewhat deeper levels, *Michtheimysis mixta* (Lilljeborg) as well as *Mysis oculata* var. *relicta* (Loven). None of the authors, however, have mentioned the occurrence of the mysid *Praunus inermis* (Rathke) which is known from the other Baltic regions. In the Baltic this boreal-arctic species has been observed along the Swedish coast as far north as the Åland Sea (Hessle/Vallin, 1934), along the coast of Finland in the area of Kvarken (Segerstrale, 1945), and in the Gulf of Riga (Shurin, 1953). It is worth mentioning that this species, which is typical for shallow waters, has also sometimes been caught in the open sea, namely in the southern and central basins of the Baltic (Shurin, 1953; Mankowski, 1959).

It might therefore be interesting to learn that *Praunus inermis* which is a northern species was present in a sample taken on 11. September 1958 in Puck Bay by means of a small bottom trawl hauled over the bottom at 4.5 m depth in position 54°41′N, 18°29′E. The bottom was muddy and overgrown with a dense underwater flora. The water had a salinity of 6.7‰ and a temperature of 17.3°C.

Two specimens of *P. inermis* (Rathke) were found in the sample. This small and rather thick

crustacean of a length of about 10 mm was easily distinguishable from the related species *P. flexuosus* (MÜLLER) because it has a characteristic short and broad tentacle scale (squama antennalis) which is only a little longer than the basis of the first tentacle. The telson is also distinguished by a relatively deep incision at the end, of a size of almost one-third of its length. A further characteristic is the number of the lateral telson spines: there are only 16.

In the same sample numerous bivalves were found, mostly *Cardium edule* LINNÉ and snails, especially *Theodoxus fluviatilis* (LINNÉ), *Potamopyrgus jenkensi* (SMITH), *Hydrobia ventrosa* var. *baltica* (NILSSON), and a few specimens of *Gammarus oceanicus* (SEGERSTRÅLE), together with *Idothea viridis* (SLABBER). There were also two larvae of an insect belonging to the family Phryganeidae.

L. ZMUDZINSKI

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Quantitative Evaluation of Zooplankton in the Central Baltic in 1960

(Table 4)

In 1960 plankton conditions in the central and northern parts of the Baltic were generally poor; the stock and biomass in the 0—100 m layer were below the long-term average values. (This should be related mainly to the lower productivity and and not to increased intensity of feeding by the fish.)

Some deviations from the normal were registered as regards distribution, growth-rate, and quantitative composition of the plankton. These deviations were in close agreement with the hydrological conditions.

As shown in Table 4, the abundance and biomass were lower in winter (February) below 25 m depth and somewhat higher in the 0—25 m layer. In 1960 the spring development occurred somewhat later as a result of the delayed heating of the waters. The numerical strength and biomass of the zooplankton were much below normal in all layers. The 25—50 m layer as well as the 50—100 m layer were especially poor, with 30% and 50% respectively of the normal values. The cool spring also influenced the specific composition of the plankton, resulting in a prevalence of *Acartia longiremis* and a scarcity of *Centropages hamatus*.

The numerical strength of the zooplankton in summer (August) was somewhat higher but the biomass values were somewhat lower than the long-term averages (111% and 88% respectively). Considerable deviations were also observed in the vertical distribution: strength and biomass in the 0—25 m layer were below the long-term average value, and those of the deeper layers were also below it. The composition in the summer was marked by a relatively higher abundance (in comparison with other years) of *Temora longicornis* and *Centropages hamatus*, while *Acartia longiremis* and *Bosmina coregoni* var. *maritima* were less plentiful.

In the autumn (Oct./Nov.) as in summer the strength and biomass of the plankton were somewhat higher in the upper layers (0—25 m) and lower than normal in the middle and deeper layers. The greatest daytime concentrations of plankton in summer and autumn were observed in the upper layers within the thermocline of 6°—10° C.

In the central and northern Baltic the feeding conditions for herring were unfavourable in comparison with the long-term average. These adverse

Table 4. Average indices for zooplankton (Crustacea) in the central Baltic in 1960

	0–10 m	10–25 m	0–25 m		25–50 m		50–100 m		0–100 m		Number of years of observations
	1960		1960	1949–60	1960	1949–60	1960	1949–60	1960	1949–60	
					Biomass, mg/m³						
February	103	91	97	90	42	50	28	37	49	54	5
May	65	31	47	71	11	35	24	48	27	53	8
August	246	350	278	269	173	188	94	134	160	182	7
October	173	135	147	131	76	112	90	125	101	123	7
					Numerical strength, No./m³						
February	2,550	2,280	2,420	2,230	1,260	1,150	765	720	1,300	1,200	5
May	12,060	5,980	8,640	11,130	1,840	3,950	605	2,820	2,920	4,870	8
August	21,250	32,560	25,620	17,650	6,100	6,910	2,390	4,080	9,120	8,180	7
October	14,720	9,740	11,500	8,440	4,570	4,840	2,040	3,270	5,040	5,020	7

conditions were further aggravated by very low temperatures in the intermediate water layer (the winter water) which hampered the vertical feeding migrations of the salaka.

Judging from the plankton indices for the upper water layers the food supply for sprat may be considered as average; if, however, the following two factors are taken into account conditions in the central and northern Baltic might not have been so satisfactory: (1) the limited period of plankton abundance due to delayed spring development, and (2) the very low water temperature at 20—30 m depth where the greatest abundance of plankton was encountered.

I. Nikolaev and Kh. K. Krievs

The Distribution of Bottom Fauna in the Eastern Baltic in 1960

(Tables 5–6)

In July 1960, 300 samples of benthos were collected with quantitative gear in the eastern Baltic, the Gulf of Riga, and the Gulf of Finland by the Latvian Fisheries Research Institute.

The year of 1960 was marked by an increase of salinity in the southern Baltic (Glowinska, 1960; Antonov, 1961); this increase of salinity was accompanied by an increase of oxygen content in the water, including the southern part of the Gothland Deep. Consequently, in 1960 the bottom fauna was distributed in this part of the Gothland Deep up to 108 m as compared with 80—90 m in 1959. The specific composition of the benthos over the area was the following: 8 species were found in this zone in 1960 whereas only 3 species were registered in 1959, namely, *Harmothoë sarsi* Kinberg, *Scolopos armiger* (O. F. M.), and *Diastylis rathkei* (Krøyer). The benthos biomass also increased from 4.62 g/m² in 1959 to 11.15 g/m² in 1960 (Table 5).

In the central part of the Gothland Deep no changes in the distribution of bottom fauna were observed.

In the northern part of the Deep the area occupied by bottom fauna was reduced in 1960,

Table 5. Average numbers and biomass of the most important benthic species in the eastern and northern Baltic in 1960 (by depths)

Depth in m	11–20		21–30		31–40		41–50		51–60	
Species	No./m²	g/m²	No./m²	g/m²	No./m²	g/m²	No./m²	g/m²	No./m²	g/m²
Macoma baltica (L.)	—	—	31	20.7	13.2	10.2	17.5	11.75	32.2	20
Mytilus edulis (L.)	1,378	64.85	130	30	11.1	18.4	5.8	2.47	0.45	0.36
Pontoporeia affinis Lindström	14	0.04	102	0.4	9.6	0.3	44.3	0.33	86.3	0.5
Pontoporeia femorata Krøyer	—	—	—	—	—	—	23.3	0.24	5.4	0.06
Mesidothea entomon (L.)	—	—	1.6	0.2	6.6	1.23	17	4.5	4.7	4.06
Diastylis rathkei (Krøyer)	—	—	—	—	0.8	+	—	—	0.9	0.01
Mysis mixta Lilljeborg	—	—	—	—	—	—	0.8	+	0.45	0.01
Harmothoë sarsi Kinberg	—	—	0.7	+	—	—	2	0.04	0.9	0.02
Terebellides strömi Sars	—	—	—	—	—	—	—	—	0.4	0.01
Scoloplos armiger (O.F.M.)	—	—	—	—	—	—	—	—	0.5	0.01
Halicryptus spinulosus Siebold	—	—	—	—	0.8	0.01	2	0.02	3.2	0.25
Nemertini	—	—	—	—	0.4	0.02	1.6	0.02	1.4	0.02
Others	28	0.23	11.7	0.8	2.0	0.63	—	0.13	0.45	0.11
Total	1,420	65.12	277	52.1	54	30.79	114	19.65	137	25.41

Depth in m	61–70		71–80		81–90		91–100		101–110	
Species	No./m²	g/m²	No./m²	g/m²	No./m²	g/m²	No./m²	g/m²	No./m²	g/m²
Macoma baltica (L.)	37.5	20.8	29	13.5	5	6.21	—	—	—	—
Mytilus edulis (L.)	—	—	—	—	—	—	—	—	—	—
Pontoporeia affinis Lindström	146.5	0.52	—	—	—	—	—	—	—	—
Pontoporeia femorata Krøyer	240	1.62	61	0.4	137	1.11	27.5	0.2	320	1.94
Mesidothea entomon (L.)	3.4	1.94	1	0.4	8.3	1.8	—	—	—	—
Diastylis rathkei (Krøyer)	—	—	1	+	2.7	0.11	—	—	—	—
Mysis mixta Lilljeborg	—	—	—	—	6.6	0.10	2.5	0.04	—	—
Harmothoë sarsi Kinberg	0.6	0.01	2	0.03	3	0.03	—	—	—	—
Terebellides strömi Sars	3.1	0.1	3	0.14	—	—	—	—	—	—
Scoloplos armiger (O.F.M.)	—	—	—	—	5	0.09	—	—	—	—
Halicryptus spinulosus Siebold	2.1	0.18	1	0.18	5	1.70	—	—	—	—
Nemertini	1.9	0.05	3	0.78	—	—	2.5	0.33	—	—
Others	0.6	0.05	2	+	—	—	2.5	0.02	—	—
Total	435	25.27	103	15.43	172	11.15	35.0	0.59	320	1.9

resulting in a corresponding expansion of the zone completely devoid of benthos. In 1960 this zone was not limited by the northern Baltic only but extended over the western part of the Gulf of Finland almost up to Tallin along the 80 m isobath. All this space was occupied by dark-coloured grounds smelling of hydrogen sulphide.

High numerical strength and biomass of *Mytilus edulis* (L.) were observed in the coastal zone over the whole eastern and northern Baltic up to the depth of 40 m, whereas populations of *Macoma baltica* (L.) were scarce: an average biomass of 20.7 g/m² in 1960 as against 76.43 g/m² in 1954.

It was also noted that the reduction in the number of the relict forms *Pontoporeia affinis* LINDSTRÖM and *Pontoporeia femorata* KRØYER was nearly doubled, which may possibly be explained by a reduced volume of river discharge and subsequent deterioration of the food supply.

Table 6. Age composition (%) in 1959 of the molluscs perished in the coastal zone at Kikhnu (Gulf of Riga)

Species	Age-groups			
	0+	1+	2+	3+
Cardium edule (L.)	51	46	2	1
Macoma baltica (L.) ...	52	25	10	13

Besides *Macoma baltica* (L.) the numerical strength of *Cardium edule* (L.) and other boreal species of Atlantic molluscs was also reduced in 1960. It was probably caused by an exceptionally low water level along the eastern coast and in the Gulf of Riga during the second half of 1959, especially in December; from this low water level, together with intensive cooling, it was concluded that there was a thick layer of coastal ice under which a large part of the molluscs perished.

If in 1959 *Macoma baltica* (L.) in the zone from the water edge to 3 m had an average strength of 141 specimens per m² then in 1960 this species was entirely absent; the numerical strength of *Cardium edule* (L.) has decreased from 8 specimens per m² in 1959 to one per square metre in 1960.

In the spring of 1960 a large number of dead molluscs, usually inhabiting the coastal zone, have formed an extensive zone over the whole coast; it was estimated that nearly 7 to 10 thousand tons of molluscs, largely one and two year-olds, have been lost in the Gulf of Riga.

A. T. SHURIN

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PART III.

THE FISH

A. Distant Northern Seas

Redfish

Danish Investigations in Godthåb Fjord

(Table 1)

Fishery with shrimp trawl for small redfish was carried out in the Godthåb Fjord (1D) in continuation of previous years' experiments.

Tables showing the length distribution of the samples will be published in the ICNAF Sampling Yearbook for 1960. The total catch was 9,997 redfish. Hauls were made in all months except in May, June, and August. In December two hauls were made, while in the other eight months only one haul was taken. A number of 281 large redfish, caught in pound nets or with a big jig in the Godthåb Fjord, were tagged with white Petersen discs.

P. M. Hansen

On the Migration Pattern of the Redfish (*Sebastes mentella* Travin) of the Bear Island/Spitsbergen Population in 1960

(Figure 1)

The study of redfish migrations is impeded by the fact that up to the present no satisfactory methods of tagging the redfish have been found. The most simple method of examing the migration rate of redfish was then to study the dynamics of the sex ratio in the migrating stocks in certain localities of the Kopytov area. Some peculiarities in the migration pattern in 1960, which had not been observed in other years, were registered and it is thought that these factors affected the terms of formation of concentrations and the results of the fishery.

Table 1. Length frequencies of redfish caught with shrimp trawl by the M/C "Adolf Jensen" in the Godthåb Fjord, 64°25′N – 50°19′W

Date, 1960	Number of hauls	Length in centimetres 6	7	8	9	10	11	12	13	14	15	16	17	18
Jan.	1	—	1	23	101	32	10	15	58	103	95	56	68	108
Feb.	1	8	10	74	409	337	67	100	190	371	429	249	261	284
Mar.	1	1	2	8	71	40	11	13	30	52	80	60	67	78
Apr.	1	—	—	5	145	178	46	47	93	194	285	199	161	227
July	1	—	—	7	15	78	142	40	23	25	45	44	44	34
Sept.	1	—	—	5	5	23	45	24	8	9	23	39	34	28
Oct.	1	—	—	3	7	13	26	26	9	9	23	45	34	26
Nov.	1	—	—	—	3	4	12	30	14	7	13	14	18	27
Dec.	1	—	—	2	5	9	19	74	64	16	28	30	48	48
Dec.	1	6	1	1	9	20	29	36	24	19	17	31	32	19

Date, 1960	Number of hauls	Length in centimetres 19	20	21	22	23	24	25	26	27	28	29	30	31
Jan.	1	69	29	19	37	37	19	20	18	7	7	6	4	3
Feb.	1	216	92	51	54	43	49	43	19	15	14	8	7	5
Mar.	1	63	26	21	11	20	16	12	12	13	11	9	4	3
Apr.	1	174	77	37	26	34	24	22	27	11	11	9	6	9
July	1	29	16	7	3	8	6	4	1	2	1	—	—	1
Sept.	1	31	26	11	9	7	11	6	5	1	2	—	—	—
Oct.	1	26	36	21	10	14	6	7	4	9	4	5	—	1
Nov.	1	17	21	21	12	4	10	7	5	1	5	2	—	—
Dec.	1	37	26	38	23	8	4	11	3	4	5	3	2	—
Dec.	1	35	41	56	27	11	11	4	8	19	11	15	19	19

Date, 1960	Number of hauls	Length in centimetres 32	33	34	35	36	37	38	39	40	>40	Number of fish
Jan.	1	5	5	4	—	1	—	—	1	1	8	970
Feb.	1	3	4	2	1	3	5	5	1	1	5	3,435
Mar.	1	9	2	8	7	16	17	21	16	11	20	861
Apr.	1	2	5	5	3	2	1	3	3	—	2	2,072
July	1	—	—	—	—	—	1	—	1	—	3	580
Sept.	1	—	—	—	—	—	—	—	—	—	1	353
Oct.	1	1	—	1	—	—	1	—	—	—	—	367
Nov.	1	[illegible]	[illegible]	—	[illegible]	—	—	—	—	—	1	248
Dec.	1	1	—	—	—	—	—	[illegible]	[illegible]	—	—	505
Dec.	1	11	11	12	6	8	9	7	6	7	6	603
												Total 9,997

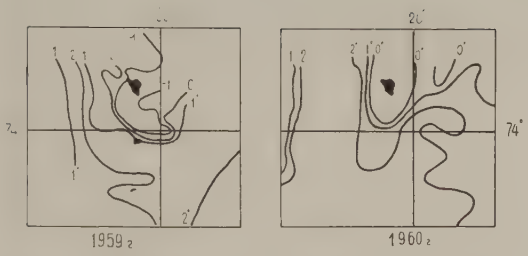

Figure 1. The distribution of near-bottom water temperatures in the Bear Island area in March/April.

In 1960 the onset of migration of the females took place in January, assuming mass character in February. This led to formation of pre-spawning concentrations of females on the slope in the south-western part of the Kopytov area. Analysis of the mature part of the stock showed that not a single male was present in these shoals concentrating on the slope in an extent of more than 50 miles.

Similar investigations were conducted in January 1958 and 1961. In January 1958, males constituted 26% of the stock present in the south-western part of the Kopytov area and in January 1961 they made up 5%. In 1959, observations on the sex composition of the concentrations started at the beginning of March, when males formed 4—9%. It is assumed that males were also present in February. When comparing these data it is seen that in the same area and at the same time the relative number of males in the pre-spawning concentrations is different, particularly in 1960, when they appeared in the southern part of the slope more than one and a half months later than in 1958 and 1961.

When comparing 1960 with 1959 it appears that in 1960 the concentration of wintering males took place a month later. The result of this delay was that the period of mass migrations of females and the beginning of migrations of males did not coincide, which affected the density of the concentrations. The fishery in the northern part of the Kopytov area, where the males usually spend the winter, was therefore unprofitable. The drop in the yield of the fishery is not to be attributed to the state of the fishing resources but to unfavourable weather conditions as well, and to a certain reduction in fishing effort.

The main reasons for the differences in the onset of the "hibernating" migration of the males must be ascribed to the temperature prevailing on the feeding grounds and the intensity of the winter cooling of the sea.

When comparing the thermal conditions on the slopes of the Bear Island Bank and the Western Gully in 1959 and 1960 we find good agreement between the rate of cooling, the migration pattern, and the results of the commercial fishery (Fig. 1). But a similar agreement is not apparent for the year 1958. That year, the general temperature conditions on the feeding grounds were considerably higher, and the rate of winter cooling was lower than in 1960. Nevertheless, in January 1958 males were found in the pre-spawning concentrations of females, making up 27%. Although the absolute number of males caught is not great — 8 specimens only — it is the very presence of males that is important. But it does not mean that the interpretation of the migration pattern of males as "wintering" is wrong. That it is a migration pattern is determined not only by the hydrological conditions observed during the migrations but, also by the conditions preceding the start of migration.

V. P. Sorokin

Halibut

Investigations off West Greenland

(Tables 2–3)

The R.V. "G. O. Sars" made a cruise to the waters off West Greenland between 28. March and 6. May 1960. The actual working time on the West Greenland banks was in the period 4. April to 26. April.

During this period attempts were made with halibut long-lines in localities where Norwegian long-liners usually and with some success are fishing for halibut in the period June to September. In Table 3 the results of these fishing experiments are set out. The yield was rather sparse, and to some extent the by-catch of halibut taken on cod bottom long-lines was better (see Table 2).

All the halibut caught were very small and immature. This may indicate that off West Greenland the mature halibut migrate from shallower and colder to deeper and warmer water during the year. The immature halibut probably remain

Table 2. "G. O. Sars", West Greenland, April 1960, cod bottom long-line stations

Date April	Position	Depth (m)	Bottom temp. (°C)	Number of hooks	Number of halibut caught
5.	61°41′N, 50°39′W	190	3.3	1,800	28
6.	61°29′N, 50°28′W	205	3.1	2,100	18
7.	62°13′N, 50°49′W	140	1.9	1,950	16
12.	65°19′N, 53°42′W	125	3.9	2,050	0
13.	64°12′N, 53°05′W	170	3.2	2,050	40
14.	64°40′N, 54°17′W	155	2.6	1,900	4
22.	63°24′N, 52°44′W	135	1.8	2,050	1
25.	62°32′N, 51°07′W	210	2.3	2,050	0
26.	62°25′N, 50°50′W	200	2.0	2,050	0

Table 3. "G. O. Sars", West Greenland, April 1960, halibut long-line stations

Date April	Position	Depth (m)	Bottom temp. (°C)	Number of hooks	Number of halibut caught
5.	61°44′N, 50°39′W	198	3.9	1,000	7
7.	62°17′N, 50°34′W	125	1.7	1,000	6
12.	64°31′N, 53°02′W	108	2.5	925	2
19.	64°14′N, 53°17′W	200	4.5	1,000	0
25.	62°32′N, 51°07′W	210	2.3	1,000	0
26.	62°25′N, 50°50′W	200	2.0	1,000	0

on the upper slopes of the banks throughout the year.

Due to bad weather on this cruise the tagging programme had to be cut short. Only 56 halibut were tagged. As usual, the tag (yellow plastic disc) was attached to the gill cover.

ERLING BRATBERG

Rare Fish

Germany

The number of rare and "exotic" fishes obtained by the German scientific institutions in Hamburg (IfS) and Bremerhaven (BAH) has been rather small in 1960. In accordance with the lines followed in the previous years, we do not mention here those species which may be considered as "resident" although they are rarely caught by commercial trawlers; they have been recorded more than once by us for the same fishing ground. Some of the bathypelagic species too, which by no means are resident in our latitudes, but seem to drift every year with some regularity into northern waters, e.g. the more common Paralepids, are excluded.

The length measurements represent, as usual, the total length. The identifications have been made by Dr. KOTTHAUS for the landings in Bremerhaven, and by the author at Hamburg and on board "Anton Dohrn".

Beryx decadactylus Cuvier & Valenciennes, 1829
Landed 20. 9. 1960, NW Iceland ("Gammelloch"), 1 ♀, 585 mm (caught by trawler), IfS.
Caught between 10. and 20. 10. 1960, 64°38′—42′ N—26°48′ W ("Schneemann"), 490—500 m depth, 1 ♀, 548 mm (caught by trawler), BAH.

Beryx splendens Lowe, 1833
Caught 12. 9. 1960, 63°07′ N—20°50′ W (S Iceland), 360 m depth, 1 ♀, 449 mm (caught by trawler), IfS[1]).

[1]) First record for our area, see Arch. Fischereiwiss., 12 (1), 1961.

Hexanchus griseus (Bonnaterre), 1788
Caught between 18. and 28. 11. 1960, SW Iceland (south of "Mehlsack"), 480 m depth, 1 ♂, 202 cm (caught by trawler), BAH.

Hoplostethus islandicum Kotthaus, 1952
Caught 5.—6. 1. 1960, 63°18′ N—16°58′ W to 63°14′ N—17°25′ W (S Iceland), 230 m depth, 2 ♂♂, 614 and 541 mm, 14 ♀♀, 659, 625, 616, 615, 606, 602, 589, 579, 578, 578, 569, 568, 561, and 561 mm (caught by trawler), BAH.

Lepidorhombus boscii (Risso), 1810
Caught 23. 6. 1960, 60°34′ N—12°33′ W (Lousy Bank), 400 m depth, 1 ♂, 20 cm, 3 ♀♀, 23, 22, 22 cm (AD Station 775/60), IfS[2]).

Nansenia groenlandica (Reinhardt), 1902
Caught 19. 6. 1960, 64°11′ N—12°13′ W (Iceland-Faroe Ridge), 445 m depth, 1, 175 mm (AD 751/60), IfS.

Paralepis brevis Zugmayer, 1911
Caught 19. 6. 1960, 64°11′ N—12°13′ W (Iceland-Faroe Ridge), 445 m depth, 1, 395 mm (AD 751/60), IfS.

Rhinochimaera atlantica Holt & Byrne, 1909
Landed 27. 9. 1960, SW Iceland ("Mehlsack"), abt. 500 m depth, 1 ♂, 115 cm, 1 ♀, abt. 130 cm, tail broken (caught by trawlers), IfS.

Squalus acanthias Linnaeus, 1758
Caught 10. 10. 1960, 64°03′ N—53°03′ W (Fylla Bank), 210 m depth, 1 ♂, 74 cm (caught by trawler), IfS[3].

G. KREFFT

Scotland

Malacocephalus laevis (Lowe) — 1: Faroe, VIII.
Lampris guttatus (Brünnich) — 1: Faroe, VII.
Aphanopus carbo, Lowe — 2: Rosemary Bank, V.
Cottunculus microps Collett — 3: Faroe, V.

B. B. RAE
J. M. LAMONT

[2]) Since the species has been caught by us the year before at the same position, but not at Faroe Bank, the Lousy Bank may be considered as the north-easternmost habitat of *L. boscii*.

[3]) Up till now there are a few scattered finds of the Spiny Dogfish in West Greenland waters only.

B. Near Northern Seas

Flatfish

German Sole Tagging Experiments in 1960

(Figures 2–8; Tables 4–6)

According to the resolutions of the "Sole Working Group" (special meeting at Ostend, December 1959) the German sole tagging experiment was continued in 1960. From May to September, 327 soles were liberated, mostly within a ten-mile circle round Helgoland and off the Isle of Amrum, as listed in Table 4. For length distribution of the tagged and recaptured fish, see Figure 2.

Table 4

Date 1960	Tagging position Lat.N	Long.E	Number of tagged fish	Returns No.	%	Vessel
19. 5.	54°09′	07°54′	25	6	24	"Uthörn"
23. 6.	54°15′	07°46′	10	2	20	"Uthörn"
9. 7.	54°07′	07°55′	21	3	14	"Anton Dohrn"
9. 7.	54°07′	08°10′	50	1	2	"Anton Dohrn"
9. 7.	54°12′	08°00′	31	1	3	"Anton Dohrn"
9. 7.	54°15′	07°46′	70	12	17	"Anton Dohrn"
10. 7.	54°32′	06°57′	7	0	0	"Anton Dohrn"
13. 7.	54°39′	03°40.5′	3	1	33	"Anton Dohrn"
15. 7.	54°47′	01°18.5′	10	0	0	"Anton Dohrn"
17. 7.	54°36′	08°03′	18	3	17	"Anton Dohrn"
18. 7.	54°17′	07°40′	4	0	0	"Anton Dohrn"
29. 7.	54°15′	07°46′	7	0	0	"Uthörn"
18. 8.	54°09′	07°54′	7	2	29	"Uthörn"
24. 8.	54°09′	07°54′	53	4	8	"Uthörn"
1. 9.	54°11′	07°54′	11	0	0	from tank exper.
		Total	327	35	11	

As in 1959, only red and yellow Petersen discs were used. The silver wire was, however, replaced by titanium wire, which has the advantage of being of a very much lighter weight than the silver wire. Its high pliability renders it difficult, however, to pierce it through the musculature of the fish. This difficulty may, however, be overcome by cutting it very slantwise so that the ends taper.

As to the method of tagging, nothing has changed compared with 1959 (Ann. Biol., **16**, 1961).

281 of the tagged fish were categorized according to vitality and scale condition (Table 5) in the following manner:—

Index "A" = active; Index "B" = sluggish.
Index "1" = no scales were missing, or only a few.
Index "2" = some small patches without scales.
Index "3" = larger patches without scales.

Moribund soles were sorted out and not used for tagging.

Up to February 1961 (incl.), 35 (i.e., 11%) of the 327 soles tagged were returned. By far the majority of these (57%) were recaptured by Dutch

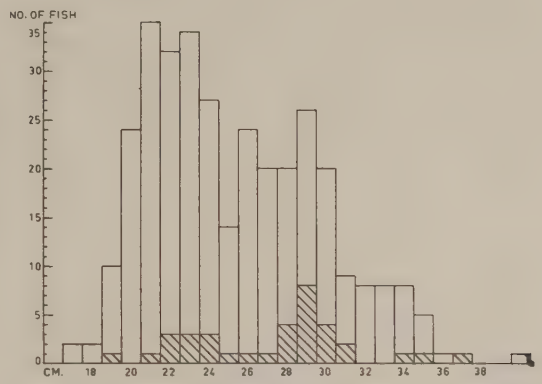

Figure 2. Length distribution of released and recaptured soles (hatched columns).

Table 5. Release and return of soles in different condition

Category	Number of tagged fish		Returns Number		Returns %	
A 1	44	133	8	21	18.2	15.8
A 2	79		13		16.4	
A 3	10		0		—	
B 1	21	148	1	6	4.8	4.0
B 2	99		4		4.0	
B 3	28		1		3.6	

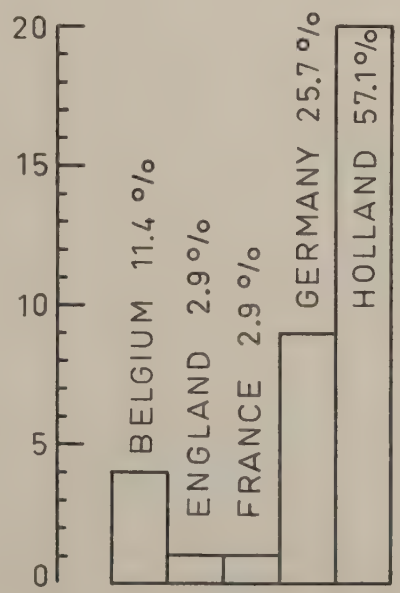

Figure 3. Number of recaptured fish by countries.

Figure 4. German sole tagging experiment, 1960.
Large marks - Tagging position.
Small marks = Position of recapture.

vessels; about 26% were returned by German, 11% by Belgian, and 3% each by English and French vessels (Fig. 3). In 27 cases the returned tags were accompanied by full particulars about recapture, in the other cases either exact date of recapture, or position of recapture were missing or the fish length was given in full centimetres.

As may be seen from Figure 4 the main direction of migration is westward just as in the experiments in the second half of 1959. The offshore migration seems to have started somewhat earlier than in 1959 (Figs. 5 and 6), for already in August and September fish were recaptured which had migrated some 70 to 100 miles westward, whereas the first long distance migrations were stated in October of 1959. There is no reason to believe that this results from an earlier beginning of the tagging in 1960, for all the fish under consideration (tags No. 809, 859, 869, 911; see Table 6) were liberated between 9. and 19. July 1960, whereas most of the fish were liberated late in June or early in July in the year 1959.

That the growth of the tagged fish differed widely can be concluded by comparing the length

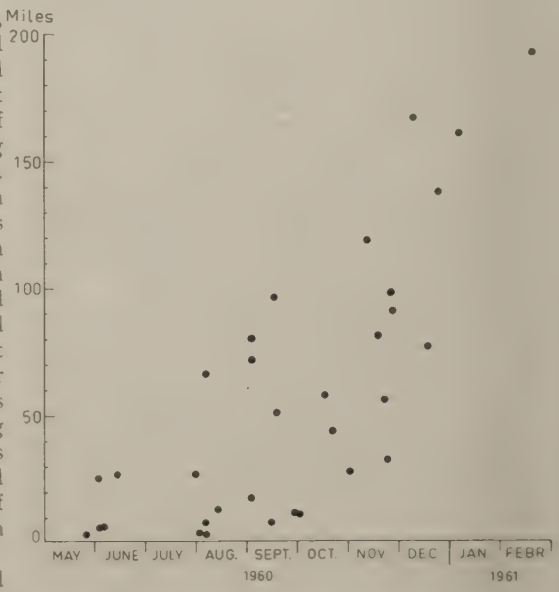

Figure 5. Displacement of tagged sole. 1960 experiment.

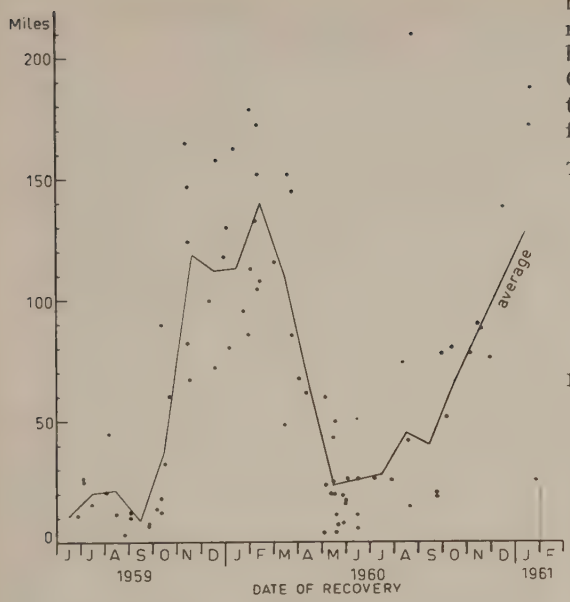

Figure 6. Displacement of tagged sole. 1959 experiment.

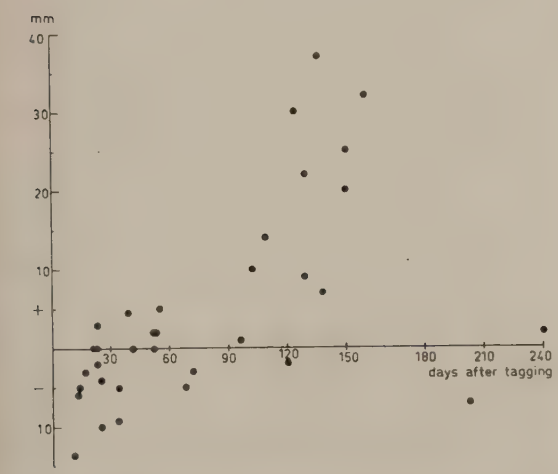

Figure 7. Difference between length at recapture and length at release.

at liberation and the length at recovery (Fig. 7). As in the 1959 experiments it was observed that the length of many fish had decreased, at least within the first two months after liberation. Mention must be made of fish No. 160 which was 202 days in the sea and whose length was 7 mm less than at tagging. This "shrinking" may partly be due to the fact that most of the fish were not measured immediately after capture, but had been gutted and put on ice, to be measured ashore. On the other hand, our tank experiments reveal that tagged fish, though supplied with sufficient food, may show deficient growth:—

Tag No.	Date of tagging	Length of the fish in mm at tagging	7. 7. 60	1. 8. 60
231	30. 4. 60	307	301	303
225	30. 4. 60	264	258	261
35	30. 4. 60	204	202	205
30	30. 4. 60	192	188	191

Table 6. Recovery data

Number of tag	Date of recovery	Days in sea	Displacement, miles	Length difference, mm	Recovered by
155	23. 5. 1960	4	ca. 2	?	Germany
158	30. 5. 1960	11	ca. 5	−16	Germany
160	7. 12. 1960	202	166	− 7	Holland
163	11. 6. 1960	23	26	+ 3	Holland
165	1. 6. 1960	13	24	− 6	Holland
176	2. 6. 1960	14	6	− 5	Germany
180	18. 2. 1961	240	192	+ 2	England
187	3. 8. 1960	41	7	0	Belgium
706	?. 11. 1960	ca. 120	?	− 2	Holland
718	12. 9. 1960	25	7	−10	Germany
721	5. 1. 1961	150	ca. 160	+20	England
724	27. 9. 1960	34	10	− 5	Germany
732	27. 9. 1960	34	10	?	Germany
753	18. 10. 1960	55	43	+ 5	Holland
762	21. 12. 1960	119	137	+14	Holland
803	30. 7. 1960	21	3	0	Germany
804	11. 8. 1960	23	12	0	Germany
809	14. 9. 1960	67	95	− 3	Holland
818	26. 7. 1960	17	26	− 3	Holland
821	?. 12. 1960	ca. 160	ca. 76	+32	Holland
823	10. 11. 1960	124	118	+30	Holland
836	14. 10. 1960	96	57	+ 1	Holland
842	3. 8. 1960	25	ca. 2	− 4	Belgium
851	19. 7. 1960	10	?	?	France
859	3. 8. 1960	23	65	− 2	Holland
862	20. 11. 1960	136	55	+37	Belgium
869	31. 8. 1960	52	71	+ 2	Holland
871	16. 11. 1960	129	80	+ 9	Holland
881	27. 10. 1960	102	27	+10	Holland
895	?. 12. 1960	ca. 150	?	+25	Holland
898	23. 11. 1960	129	97	+22	Holland
901	30. 8. 1960	52	16	0	Germany
908	24. 11. 1960	138	90	+ 7	Holland
911	31. 8. 1960	53	79	+ 2	Holland
963	15. 9. 1960	68	50	− 5	Holland

These results lead to the assumption that the minus values of "growth" are, at least partly, brought about by a real "shrinkage" after tagging. It must, however, be stated that no untagged fish have been measured at the same time and under the same conditions, so that it cannot yet be decided, whether the shrinkage is entirely due to the tagging itself, or whether deficient growth is a normal phenomenon in soles transplanted to

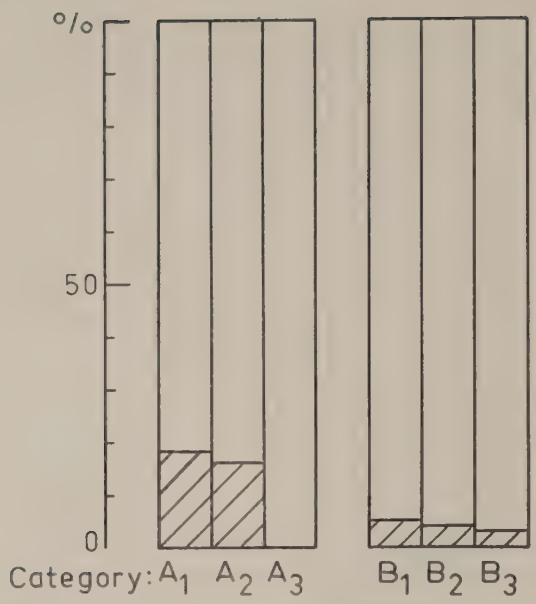

Figure 8. Rate of return (%) of fish in the different conditions.

an aquarium. Experiments to solve these questions are planned for the year 1961.

At any rate, the shrinkage of the fish in the first weeks after tagging must be taken into consideration when calculating growth-rates from tagging experiments. The length increment given is therefore to be considered as a minimum growth.

As mentioned above, 281 soles have been categorized according to their activity and scale condition before liberation. From these fish 27 (about 10%) have been returned. Comparing the rate of recapture in the different categories we conclude that "A" fish is superior to "B" fish, both in absolute numbers and in percentages, as is shown by Table 5 and Figure 8: 15.8% of category "A" have been returned, compared with only 4.0% of the "B" category. Furthermore a decreasing rate from group "1" to group "3" can be noted. From these data we conclude that the survival rate depends directly on the condition of the fish at tagging; i.e., that the fish in good condition has a higher rate of survival than fish in poor condition. These results tally with English observations.

These facts must be taken into consideration in estimating the fisheries mortality from the rate of return of tagged soles.

A. Kotthaus

Age Composition of the Plaice Populations in the Southern North Sea

(Figures 9–11; Table 7)

Several difficulties were encountered in assessing the age composition of plaice populations. Most of those arose in the sampling procedure and it is desirable to reduce their effects as far as possible.

When plaice samples are collected on the spawning grounds in the spawning season the effects of an uneven distribution of the fish owing to depth of the water, different dispersion of the year-classes, etc. are more or less eliminated. Moreover if different sub-populations exist, these can best be studied in the spawning season, for such sub-populations may in other seasons intermingle and thus the existing differences will be obscured.

Studies of the meristic characters of mature plaice from different spawning grounds, and the results of tagging of mature plaice, yielded data indicating that the plaice tends to stick to the same particular spawning ground throughout its span of life, and that the rate of change in spawning site, if such occurs, must indeed be low. (These data will be published elsewhere.)

Data on age distribution on the different spawning grounds can therefore yield indications on the extent and variation in mortality rate of plaice belonging to different sub-populations.

The areas studied were the spawning centres of the Southern Bight and the German Bight, together with an intermediate region (see Fig. 9).

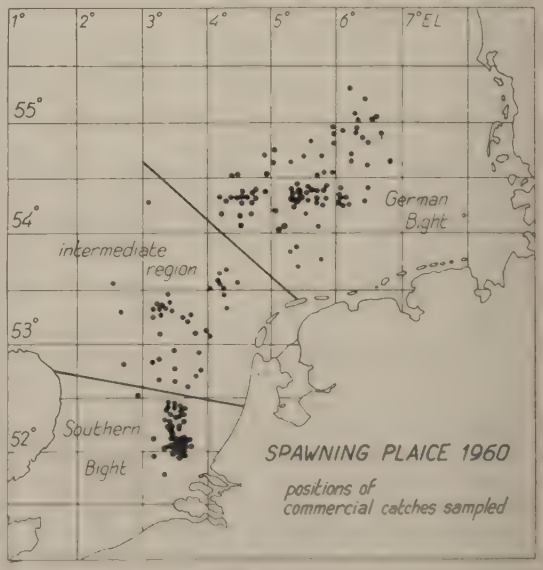

Figure 9.

Table 7. Age composition of mature plaice in the commercial catches of Dutch cutters and luggers expressed in the catch of a standard ship (200 BHP) fishing for 50 hours

Area	Year-class	1957	1956	1955	1954	1953	1952	1951	1950	1949	1948 and older
Southern Bight	♂	820	508	262	383	205	115	34	33	27	1
	♀	60	41	13	79	29	19	8	16	10	24
Intermediate region	♂	126	921	271	334	99	31	30	31	14	7
	♀	7	67	34	72	60	18	4	1	4	34
German Bight	♂	128	666	164	223	92	21	8	3	3	2
	♀	2	58	23	35	51	15	13	22	1	14

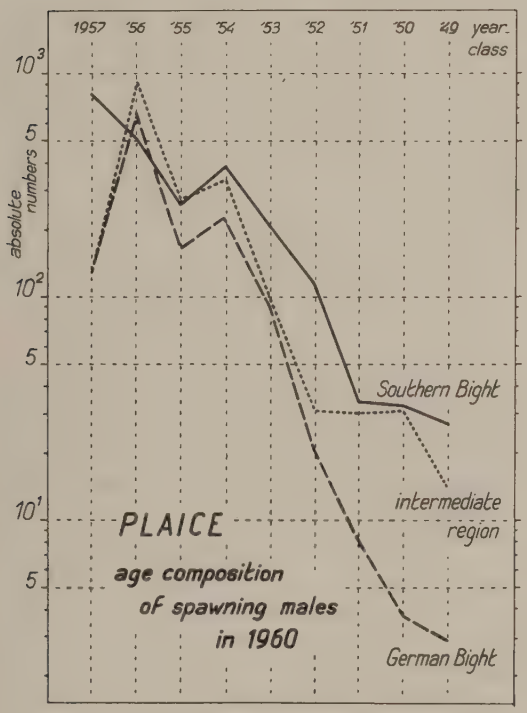

Figure 10.

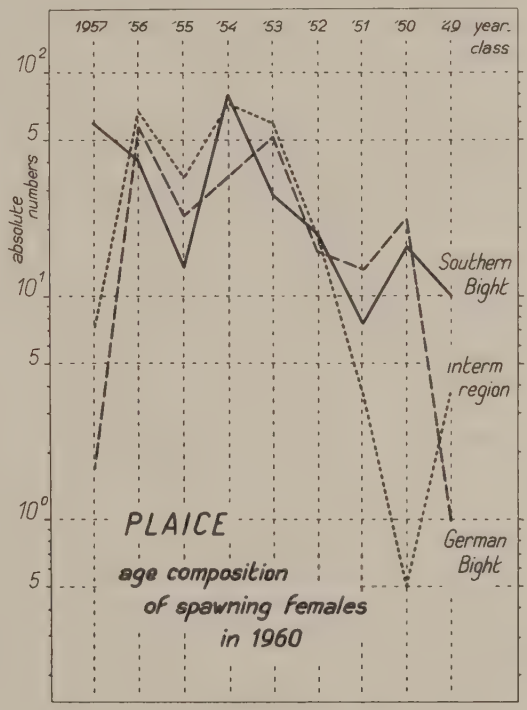

Figure 11.

Samples of mature plaice were collected from commercial landings at IJmuiden and Scheveningen, in the period January to mid-March 1960.

Otolith samples taken in addition to market measurements made it possible to convert length distributions into age distributions by means of length/age keys.

During the spawning season a new length/age key for mature males was calculated per area every fortnight. This was impossible for the mature females, owing to the relative scarcity of the latter on the spawning grounds compared with mature males. For females only one length/age key could be obtained per area for the entire season.

The age compositions throughout the spawning season are given for the three regions studied in Table 7 and Figures 10 and 11. The age frequencies are given in absolute numbers caught by a standard ship (200 BHP) fishing for 50 hours (being the approximate average engine power and number of hours fished per trip).

The graphs demonstrate a striking difference between males and females in the decline in numbers of the subsequent year-classes; further, in the case of males, between the Southern Bight and the German Bight.

The average annual decrease is about 30% for the females, 40% for the males in the Southern Bight; 57% for the malesi n the German Bight, as deduced from the average slopes of the curves.

These differences in annual decrease tally very well with our knowledge of the plaice fishery and of the biology of the plaice:

The German Bight population is heavily fished for more than two months in succession during the spawning season, whereas the Southern Bight plaice is in that period protected by rough grounds where little fishing takes place[1]).

This will particularly affect the males because mature females remain for a short time only on the spawning ground, whereas males stay there for a much longer time (HEFFORD, 1916: Fish. Invest. Lond., Ser. 2, 3 (3) : 34–40).

Whether the decrease in numbers of subsequent year-classes really provides a good indication of the average total mortality depends on the question whether it is correct to assume that:

(a) the recruitment fluctuated around a constant value throughout the years under consideration;
(b) there is no change in catchability with age;
(c) after reaching a given age, no change takes place in the relative numbers of the year-classes participating in spawning.

J. F. DE VEEN

Danish Investigations on Young Flatfish in Coastal Waters, and on Plaice in Open Waters in the Year 1960

(Tables 8–10)

The 0- and I-group of plaice, flounder, turbot, brill, and sole

According to Table 8 the strength of the 0-group plaice was below normal in the northern and central Kattegat, though not so much as the figures seem to indicate. *Cyanea capillata* was unusually abundant in the northern Kattegat and hampered the fishing in most of the stations, even in the 10-min. hauls. In the central Kattegat the heavy swell undoubtedly gave too low catches in most of the hauls. In the southern Kattegat the strength of the 0-group plaice was about normal at the few stations on the Danish coasts. In Skälderviken and Laholm Bay fishing was carried out with permission of the Swedish Government, and here the amount of 0-group plaice appeared to be 5 times greater than at the Danish coastal stations. These bays are of very great importance for the stock of the southern and central Kattegat.

[1]) The distribution of the positions of the samples in Fig. 9 may easily be misunderstood as reflecting the fishing intensity. This is not the case. Most of the fishing occurs in the German Bight area and it was difficult to get enough samples from the Southern Bight. It was not possible to get samples from the centre of the Southern Bight spawning ground.

Table 8. Numbers of 0- and I-group plaice, and 0-group sole caught per hour with the Johansen young-plaice trawl (with iron chain) in July–August 1960 (Preliminary figures. In brackets means for a series of years)

	No. of stations	Plaice 0-group	Plaice I-group	Sole 0-group
Northern Kattegat .	21	100	81	0
		(281)	(83)	
Central Kattegat ..	5	14	10	0
		(111)	(18)	
Southern Kattegat				
Danish coasts ..	5	53	9	19
		(60)	(3)	
Swedish coasts .	16	261	22	28

Table 8 indicates that the strength of I-group plaice in the northern Kattegat was about normal. In 1959 the numbers of 0-group plaice was below normal here, but we know that immigration from the Skagerak often takes place.

In the central Kattegat the number of I-group plaice was below normal, as was the 0-group in 1959; in the southern Kattegat this group seemed to be over normal, but the number of stations was too small on the Danish coasts for valid conclusions to be drawn.

The number of 0-group flounder seems to have been extraordinary small. On the Swedish coast the 0-group flounder is usually abundant. The 1960 observations reveal a different pattern: the number of 0-group flounder was only 1 per 60-min. haul on the Swedish coast. At the Danish coastal stations of the Kattegat the 0-group flounder is usually of very sparce occurrence. In 1959 rather many 0-group flounders were found in the central Kattegat; in 1960 a few I-group flounders were found there. In the Swedish bays the 0-group flounder was abundant in 1959, and relatively many I-group fish were found there in 1960 (about 1 per 60-min. haul).

Of turbot no 0-group specimens were found at any of the coastal stations; I-group fish were encountered in the Laholm Bay where some 0-group turbot occurred in 1959.

0-group brill was not found in 1960, but a few of the I-group were observed in the northern and southern Kattegat.

0-group sole was found in relatively great numbers in the southern Kattegat.

The stock of plaice in the Kattegat at more than 5 metres depth

The results of the investigations with the "Biologen", carried out in June and October, are shown in Table 9. It can be seen that the II- and III-groups dominated the catches, and that their length was in June predominantly 11—25 cm in

Table 9. Length and age distribution of plaice in the Kattegat in 1960

(Number per hour. Preliminary figures. Length measurements to the nearest lower whole centimetre. Gear S: Standard trawl, H: Nephrops trawl)

	Depth, m	Gear	No. of hauls	Age-groups I	II	III	IV	V	Length groups, cm 10	11–15	16–20	21–25	26–30	31–35	36–40	Total
Northern Kattegat																
June	6–14	S	5	4	37	65	2	—	2	6	25	63	12	—	—	108
	15–24	S	3	14	75	47	3	—	5	39	46	64	3	—	—	139
	40	H	2	—	13	44	4	—	—	2	10	23	15	10	1	61
October ...	20	S	2	—	9	10	—	—	—	—	3	12	2	2	—	19
	38–76	H	6	2	2	0.7	—	—	0.3	1	1	2	0.3	—	—	5
Central Kattegat																
June–July .	6–14	S	3	—	—	—	—	—	1	60	13	—	—	—	—	74
	70	H	1	—	50	34	6	—	—	—	—	38	40	10	2	90
Southern Kattegat																
Sept.–Nov.	21–24	S	7	0.6	0.3	1	2	0.6	—	—	0.3	0.6	2	1	0.3	5

depths up to 25 m, but larger at greater depths. In June 1959 the II-group, the very rich 1957 year-class, dominated the catches, but in June 1960 their number was reduced to about one-fifth. The amount of plaice over the commercial size limit was about one-fourth of that in June 1959.

A considerable density of small plaice was found in the central Kattegat, outside the Mariagerfjord, in June—July. They appeared to be I-group plaice. According to the investigations in coastal waters in 1959, the 1959 year-class was poor in the central Kattegat and good in the northern and southern Kattegat.

No doubt an immigration has taken place in 1960, as in many previous years, but most unfortunately a racial investigation has not been carried out, and therefore we do not know whether the plaice have come from the north or from the south. Relativelly many II- and III-group plaice were found at one station in the deep eastern Kattegat. Many of those were over the Danish size limit.

Hauls were made at 21—24 m depth in the southern Kattegat. The stock was relatively sparce here, but most of the plaice were over the commmercial size limit and appeared to belong to the III- and IV-group. It may seem peculiar that the 1956 year-class, which was poor in the southern Kattegat, was the richest one, now, but possibly the age determinations are not fully correct.

Commercial catches of plaice in the Skagerak and Kattegat

North of the Scaw the average length of plaice caught in depths of under 10 m was about 28 cm, which is only a few cm over the Danish commercial

Table 10. Length distribution (‰) and average length of plaice in Danish commercial catches from the Skagerak and Kattegat in Danish seine and trawl

(Length to nearest lower whole cm, mean corrected)

	Depth, m	No. of samples	Length, cm 26—27	28—30	31—35	36—40	41—45	46—50	51—54	Mean
Skagerak N of Skagen										
1960 October	6—7	2	50	45	5	—	—	—	—	28.2
1958 November	23—43	2	13	11	43	25	—	—	—	34.3
1960 October	34	1	22	40	22	14	20	—	—	31.2
Ca. 25 miles north of Fornæs										
1959 May–September ...	9—15	7	26	35	35	4	—	—	—	30.4
1960 July–August	14—15	4	33	37	23	6	—	—	—	29.9
Ca. 10 miles north of Djursland										
1959 May–September ...	6—14	10	19	36	41	4	—	—	—	30.8
1960 June–September ...	10—13	4	19	34	36	10	1	—	—	31.4
About midway Fornæs–Anholt										
1959 Nov.–Dec.	17—35	3	4	19	37	35	4	—	—	34.3
1960 Nov.–Dec.	21—35	3	8	14	48	21	9	—	—	34.3
1960 December	16—20	2	56	27	14	3	—	—	—	28.7
S of Grenå near coast										
1959 December	17—20	2	14	30	36	10	8	2	—	32.6
1960 December	16—18	3	18	32	28	16	5	—	—	32.1
7—15 miles SE and SSE of Grenå										
1959 Aug.–Dec.	19—20	3	8	19	52	15	5	—	—	33.2
1960 Aug.–Dec.	19—28	4	11	20	50	15	3	1	—	33.0

size limit, 26.0 cm. In greater depths the length was about 3 cm less than at the same time of the year in 1958. In Ann. Biol. XVI it is explained that this decrease of the average length occurred in the spring of 1958 on account of the large recruitment to the commercial stock from the rich 1957 year-class.

The fact that the average length of the commercial fish is here about the same as in 1959 is due to the recruitment from the rich 1958 year-class.

An important fishery for plaice was carried out in the central Kattegat in July/August.

There was considerably less fishing in the western part of the central Kattegat in the summer of 1960 than in 1959, when the fishery was unusually intensive on account of a great immigration of the rich 1958 year-class from the northern Kattegat. Yet is was a very important fishing ground for the Grenå cutters during the period July/August. About 25 miles north of Fornæs the mean length of the plaice was nearly the same in the two years under consideration, i. e. about 30.0 and 30.5 cm respectively, and varying from one sample to another from 29 to 32 cm.

A similar spreading of the mean length in the catches was found in samples from about 10 miles north of Djursland; the means for 1959 and 1960 were here 30.8 and 31.4 cm respectively.

AAGE J. C. JENSEN

Norwegian Dogfish Tagging

(Figures 12–13; Table 11)

The Norwegian dogfish taggings and the total number of recaptures are presented in Table 11.

The first fish tagged (Lib. No. 1) have now for two years been in the sea and the recaptures are numerous enough to present a picture of the migrations of dogfish between Shetland and Norway and vice versa. This is illustrated in Figure 12 A and B, where each dot (Dec./Apr.) or open circle (May/Nov.) represents one recovery. It is obvious that most of the fish migrate towards the Norwegian coast in winter and return to the grounds northwest of the British Isles in summer. In the first two seasons (Fig. 12 A) there are few exceptions to this rule. One of these is very striking: in June 1959 a recovery was made by a Soviet trawler at the

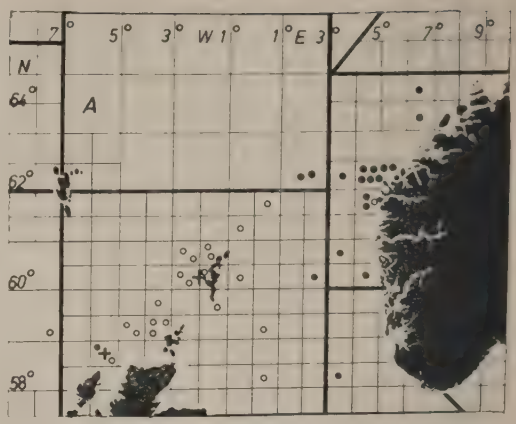

Figure 12 A. Norwegian dogfish tagging, liberation No. 1.
+ = tagging locality, November 1958.
● = recaptures December 1958/April 1959.
O = recaptures December 1959/April 1960.

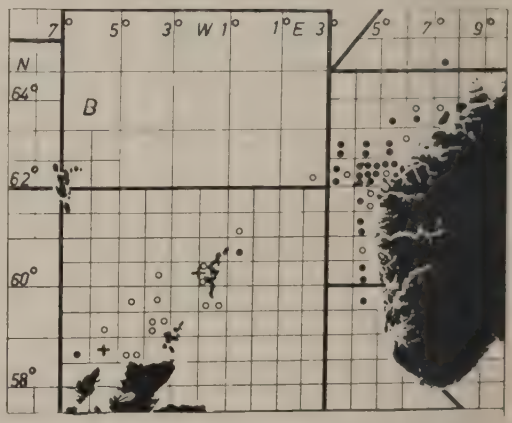

Figure 12 B. Norwegian dogfish tagging, liberation No. 1.
+ = tagging locality, November 1958.
● = recaptures May/November 1959.
O = recaptures May/November 1960.

Table 11.

Liberation No.	Region	Taggings Date	Taggings Number	Recaptures 1958	1959	1960	Total	%
1	Shetland	Nov. 1958	1,000	6	43	59	108	10.8
2	Shetland	Nov. 1959	989	—	4	55	59	6.0
3	Norway	Jan. 1960	531	—	—	47	47	8.9
4	Norway	Apr.–May 1960	10	—	—	2	2	20.0
5	Shetland	July–Aug. 1960	969	—	—	8	8	0.8
6	Norway	Nov.–Dec. 1960	250	—	—	1	1	0.4
		Total	3,749	6	47	172	225	6.0

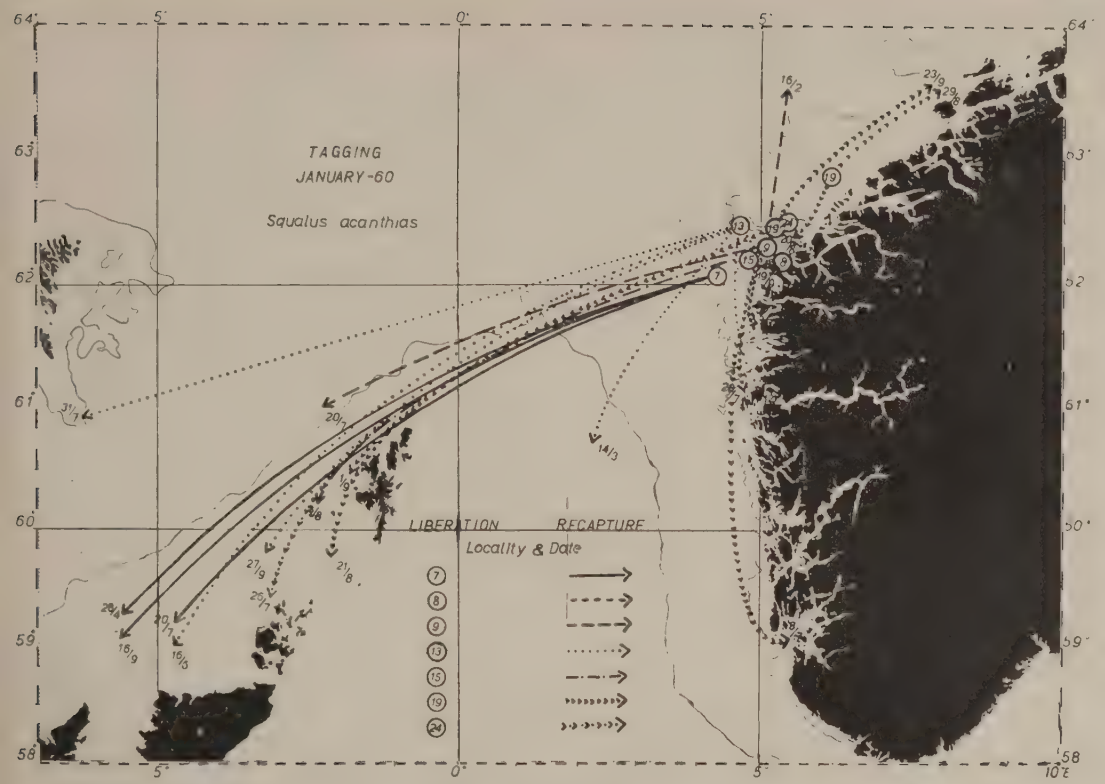

Figure 13. Norwegian dogfish tagging, liberation No. 3 (first tagging experiment in Norwegian waters). Recaptures within the first nine months after tagging. An additional 8 tags, recovered close to the release positions soon after tagging, are not included.

Thor Iversen Bank (73°N, 37°E). This fish was tagged at Sulisker (north of the Hebrides) in November 1958 and has consequently travelled about 1400 naut. miles in about 7 months. The recaptures from the 1959 taggings (lib. No. 2) conform with the same migration pattern, but here also exceptions may occur. Long-distance migrations are again demonstrated by a recovery in the Vestfjord (Arctic circle) in August 1960.

A comparison between Figure 12A and B reveals that there were considerably more recaptures on the Norwegian coast during the summer (May/Nov.) of 1960 than in the corresponding period of 1959, which indicates that a substantial portion of the stock will have remained in Norwegian waters throughout 1960. This feature is also borne out by Figure 13, which illustrates the results from the first dogfish taggings on the Norwegian coast (January 1960, liberation No. 3).

OLAV AASEN

English Spurdogfish Tagging

(Figure 14; Table 12)

Between 15.—17. November 1957, 6.—16. December 1958, and 11.—12. December 1959 small numbers of dogfish (*Squalus acanthias*) were tagged in the area bounded by the parallels 54°14'N, 53°35'N, 05°53'W and 05°15'W. A total of 278 fish were liberated. The fish were tagged using either a Petersen disc at the base of the first dorsal fin or a plastic flag tag on a braided nylon bridle sewn through the back between the dorsal fin using a

Table 12.

Year of tagging	Number released	Number recaptured up to 28. 2. 61	Percentage recapture
1957	32	3	9.4
1958	146	7	4.8
1959	100	5	5.0
Total	278	15	5.4

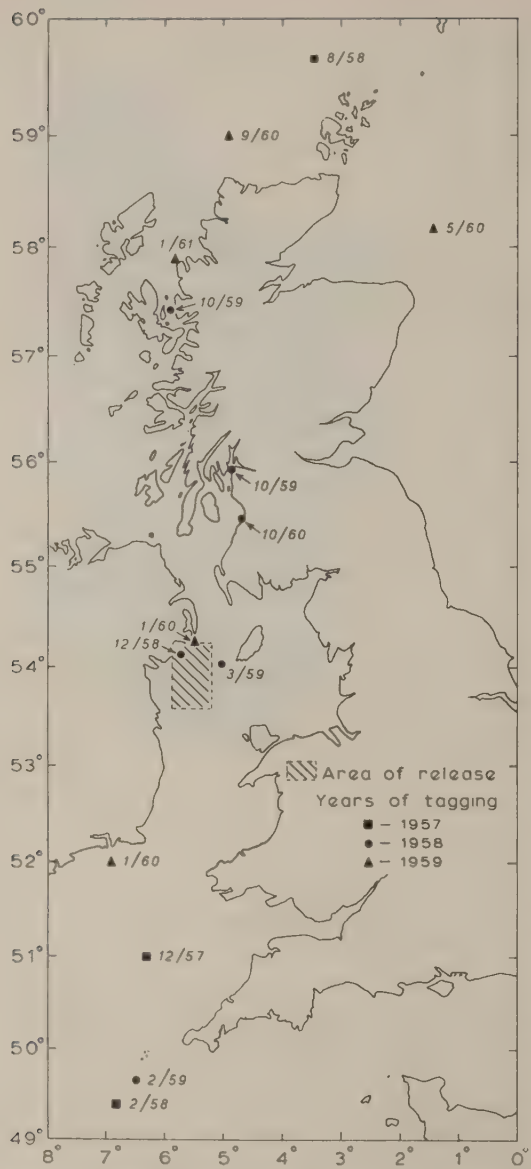

Figure 14. Area of release (cross hatched) and position, month and year of recaptures of spurdogfish tagged in the Irish Sea. Year of tagging ■ 1957, ● 1958, ▲ 1959.

surgical needle, or both. The recaptures up to 28. February 1961 are shown in Table 12 and the movements of those fish for which the recapture position was obtained in Figure 14.

M. J. Holden

Table 13. Length distribution (‰) of *Ammodytes lancea marinus*

cm:	9	10	11	12	13	14
1959 ..... n = 4,066	—	—	—	1	10	78
1960 ..... n = 1,986	2	61	219	200	139	83

cm:	15	16	17	18	19	20	21
1959	238	201	218	198	50	5	1
1960	21	14	47	133	64	13	4

The German Sand-eel Fishery in 1960

(Table 13)

Unlike previous years, only little attention has been paid by German fishermen to sand-eel fishing in the year 1960. The landings, amounting to 7,733 tons = 619,000 DM, showed a considerable decline compared with those of 1959, when 17,246 tons were caught. This development is a result of the world-wide drop in fish meal prices.

Like in the previous years, the fishing season started in April and came to an end in August. Nearly 60% of the yield was obtained in June, and another 27% in May. The most important fishing grounds were SW-Spit and Well-Bank. Four samples, containing 2,073 specimens of the unsorted sand-eel catch, were analysed at the Institut für Küsten- und Binnenfischerei for species and size composition; 86.1% of the total catch appeared to be sand-eel, 10.6% whiting, 1.5% gurnard, 1.1% horse mackerel, 0.6% cod, 0.1% dab and other species of fish. Undersized protected fish had a share of 0.8% in the total catch; 0.6% of these were cod, and 0.2% whiting.

As in previous years *Ammodytes lancea marinus* was the main species of sand-eel caught by the German fishery. Only 32 (= 1.6%) out of 2,018 specimens belonged to the species *A. lanceolatus*. The length distribution of *A. lancea marinus* is given in Table 13. The difference in size distribution in different years indicates that the strength of the year-classes fluctuates considerably in this species of fish.

P. F. Meyer-Waarden

Rare Fish

Germany

In the year 1960 the following rare fishes were caught by trawlers and landed in Bremerhaven: —

Alopias vulpes Gmelin, ♂, abt. 450 cm total length, 57°00′N, 01°30′E, September 1960. ♀, 406 cm, 59°03′N, 03°20′E, October 1960.

Alosa alosa (L.), ♀, 57 cm, 59°00′N, 03°00′E, November.

Brama brama Bonaparte, 55 cm, 59°00′N, 03°00′E, 20. November.

Lampris guttatus (Brünnich), ♀, 110 cm total length, 99 cm standard length, 59°10′N, 03°15′E, November.

A. Kotthaus

Netherlands

Rare fishes, recorded at the Netherlands fish markets in 1960 were the following: —

Myliobatis aquila (L.)
29. January; 53°15′N, 04°10′E.

Cepola rubiscens L.
20. February; 51°50′N, 07°30′W.

Maurolicus mülleri (Gmelin)
12. March; 54°00′N, 00°48′E.

Solea lascaris (Risso)
7. April; 53°05′N, 04°10′E.

Box boops (L.)
20. October; 52°23′N, 03°20′E.

Lepidopus caudatus (Euphr.)
6. June; 60°05′N, 02°36′E.

Sciaena aquila (Risso)
8. September; 53°00′N, 04°30′E.

Capros aper (L.)
30. September; 54°03′N, 04°35′E.

J. J. Zijlstra

Scotland

The following rare fishes were recorded in Scotland in 1960: —

Squatina squatina (L.) — 5: Shetland, II, X; Butt of Lewis — North Rona, IV(2); Firth of Forth, VII.

Torpedo nobiliana Bonaparte — 4: Between Orkney and Shetland, IV; Moray Firth, X; off Firth of Tay, XI; Firth of Clyde, XII.

Trygon pastinaca (L.) — 4: Off Cape Wrath, II; Moray Firth, V; Aberdeenshire Coast, VIII; Firth of Clyde, X.

Myliobatis aquila (L.) — 2: North coast of Scotland, I; SE Orkney, XI.

Acipenser sturio L. — 4: Aberdeenshire Coast, VI; east of Firth of Tay, VI; east of Firth of Forth, VI; Moray Firth, XII.

Alepocephalus bairdii Goode and Bean — 1: 60′N by W of Butt of Lewis, VII (reported by Dr. J. W. Jones, Department of Zoology, University of Liverpool).

Alosa alosa (L.) — 5: Minch, III, VI, VIII; Aberdeenshire Coast, VIII; east of Firth of Forth, XII.

Alosa finta (Cuvier) — 4: Northern North Sea, II; 110′E by N from Aberdeen, IV; east of Firth of Forth, II, XII.

Maurolicus mülleri (Gmelin) — 30: Moray Firth, II.

Sardina pilchardus (Walbaum) — West coast (Coll Bank), IX (large numbers); east of Firth of Forth, XII(3).

Engraulis encrasicholus (L.) — 6: East of Pentland Firth, IX(1); Aberdeenshire Coast, XII(5).

Oncorhynchus gorbuscha (Walbaum) — 1: Near Aberdeen, VII.

Scomberesox saurus (Walbaum) — 5: Berwickshire Coast, I; Firth of Forth, II; Aberdeenshire Coast, II, X; west coast, XI.

Belone belone (L.) — 4: Minch, III(1), XII(3).

Macroramphosus scolopax (L.) — 1: St. Kilda, V (reported by Dr. J. W. Jones, Department of Zoology, University of Liverpool).

Lampris guttatus (Brünnich) — 1: Loch Scresort (Rum Island, west coast), V.

Morone labrax (L.) — 2: Moray Firth, VI; Firth of Clyde, XII.

Brama raii (Bloch) — 12: 45′NW of Butt of Lewis, X; Moray Firth, X(1), XI(3), XII(1); Aberdeenshire Coast, X(1), XI(1); Minch, XI; Shetland, XI(2); near Firth of Forth, XI.

Mullus surmuletus L. — 4: Moray Firth, VI, XI; Shetland, VIII; Scottish east coast, XI.

Spondyliosoma cantharus (Gmelin) — 2: Moray Firth, II; Shetland, XI.

Mugil chelo Cuvier — 9: Moray Firth, VII.

Mola mola (L.) — 1: Lunan Bay (east coast of Scotland), XII.

B. B. Rae
J. M. Lamont

C. Baltic-Belt Seas

Eggs and Larvae of Various Species

(Table 14)

In the 1960 spawning season, the average numbers of eggs per m² near the "Fehmarnbelt" lightvessel were as given in Table 14.

Table 14.

	Cod	Plaice	Flounder and dab	Sprat	Mackerel
Dec.	—	0.5	—	—	—
Jan.	5	1.0	—	—	—
Feb.	12	1.0	2	—	—
Mar./Apr. (no obs.)	—	—	—	—	—
May	4	—	12	6	—
June	—	—	16	18	7
July	—	—	6	8	1
Aug.	—	—	1	6	—

As a break in the observations in March/April was caused by repairing the Hensen net, comparable data cannot be given for cod, plaice, and flounder. For dab and sprat, a higher density of eggs were recorded (sum of monthly mean number per m² 32 and 36 respectively, against 24 and 0 resp. in the previous year). The number of mackerel eggs was remarkably lower (8 against 28), probably due to low water temperature and little inflow of water of high salinity.

Additional hauls at some stations in the Kiel Bay during 4 trips by R. V. "Hermann Wattenberg" in January/March showed that the cod eggs were most frequent in February, those of the plaice in February/March, and of the flounder in March/April. The density of these eggs in the deeper parts of the Kiel Bay (more than 25 m) was about threefold that in the Fehmarnbelt region. Obviously the fish prefer the region of high salinity in the bottom water for spawning, apart from the main current in the Belts.

R. Kändler

Quantitative Fishing of Demersal Fish with the Standard Trawl

(Tables 15–17)

The trawling experiments carried out since 1956 according to the recommendation of the Baltic-Belt Seas Committee were continued in 1960 with R. V. "Hermann Wattenberg" on various fishing grounds in the Kiel Bay on 2.—5. February, 8.—9. June, and 20.—26. October. The results concerning the length and age distribution of gadoid and flatfishes are shown in Tables 15—17.

Table 15. Length and age distribution of cod, whiting, plaice, flounder, and dab taken with the standard trawl in the Kiel Bay, 2.–5. February 1960

	Number per 1 hour's fishing				
Length, cm	Cod	Whiting	Plaice	Flounder	Dab
6–10	3.7	—	—	—	0.9
11–15	121.3	40.0	—	—	27.3
16–20	173.1	61.0	0.4	—	28.0
21–25	38.3	9.9	6.0	3.7	15.0
26–30	19.6	1.4	10.0	8.3	6.8
31–35	27.4	1.9	5.1	6.8	1.3
36–40	7.0	0.3	1.9	1.6	0.1
41–45	6.9	0.1	0.6	0.7	—
46–50	5.8	—	0.1	0.3	—
51–55	3.6	—	—	—	—
56–60	1.1	—	—	—	—
>60	3.3	—	—	—	—
Age-group					
0	336.6	109.9	—	—	—
I	54.8	4.0	7.4	0.3	54.4
II	13.7	0.7	13.4	10.7	17.9
III	3.6	—	2.4	7.4	5.3
IV	0.8	—	0.6	2.3	1.4
V+	1.6	—	0.3	0.7	0.4
Total number	411.1	114.6	24.1	21.4	79.4
Number examined	2,878	802	169	150	556

Table 16. Length and age distribution of cod, whiting, plaice, flounder, and dab taken with the standard trawl in the Kiel Bay, 8.–9. June 1960

	Number per 1 hour's fishing				
Length, cm	Cod	Whiting	Plaice	Flounder	Dab
6–10	—	—	—	—	0.8
11–15	19.4	0.8	1.4	—	18.4
16–20	33.4	3.2	1.4	—	46.0
21–25	13.4	0.6	1.0	—	15.6
26–30	3.4	—	4.4	0.2	6.4
31–35	2.8	—	3.8	0.4	2.8
36–40	2.0	—	0.6	—	—
41–45	0.8	—	—	—	—
46–50	0.6	—	—	—	—
51–55	0.2	—	—	—	—
56–60	0.4	—	—	—	—
> 60	0.8	—	—	—	—
Age-group					
I	68.6	4.0	2.4	—	1.0
II	6.6	0.6	4.8	0.2	62.2
III	1.0	—	5.0	0.2	20.0
IV	0.4	—	0.2	—	4.8
V+	0.6	—	0.2	0.2	2.0
Total number	77.2	4.6	12.6	0.6	90.0
Number examined	386	23	63	3	450

The data are based in February on 7 hauls, in June on 5 hauls, and in October on 10 hauls. The results of the trawling experiments differed in some respects greatly from each other.

Table 17. Length and age distribution of cod, whiting, plaice, and dab taken with the standard trawl in the Kiel Bay, 20.–26. October 1960

	Number per 1 hour's fishing			
Length, cm	Cod	Whiting	Plaice	Dab
6–10	117	18.0	—	—
11–15	247	127.0	—	6.6
16–20	36	70.0	3.8	22.6
21–25	69	8.4	9.0	42.5
26–30	58	6.5	3.2	13.0
31–35	24	0.4	1.3	2.3
36–40	7.0	—	0.6	—
41–45	5.5	—	—	—
46–50	3.5	—	—	—
51–55	1.7	—	—	—
56–60	2.1	—	—	—
>60	0.2	—	—	—
Age-group				
0	385.0	215.3	—	—
I	169.4	15.0	14.1	10.7
II	13.5	—	2.4	61.5
III	3.2	—	1.4	11.8
IV	0.6	—	—	2.5
V+	—	—	—	0.5
Total number	571.7	230.3	17.9	87.0
Number examined	4,574	1,842	143	696

Cod

The 1959 and 1960 year-classes (age-groups I and 0) were caught in large quantities. Especially the 1959 year-class was very frequent in February and in October 1960, thus confirming its great abundance suggested from the catches in July 1959, though the numbers obtained in October 1959 and June 1960 were not so high as expected. In the autumn the largest specimens had reached marketable size (20% over 30 cm in length), and increasing catches of cod in the western Baltic may be expected by this rich year-class as well as by the following 1960 year-class which seems also to be rather abundant. Older age-groups were relatively scarce as in the preceding years.

Whiting and other gadoid fish

Many small whiting of the 0-group, mostly 10 to 20 cm in length, were caught in February and October, belonging to the 1959 and 1960 year-classes. They were brought in from the north by the bottom current, together with some species of gadoid fish normally rare or absent in the western Baltic. The following species were recorded in the catches with the standard trawl:—

In February: 66 *Gadus esmarkii*, 7—14 cm in length (0-group),
8 haddock, 17—23 cm (0-group), 33 cm (I-group),
3 *Gadus minutus*, 13—15 cm (0-group).

In June: 52 *Gadus esmarki*, 9—14 cm (0-group).

In October: 5 haddock, 15—18 cm (0-group).

Plaice

The 1957 year-class dominated in the catches obtained in February, and even in June it exceeded the following 1958 year-class, which was less abundant. In October young plaice of the I-group were caught in rather high numbers, and the growth of this year-class originating from the warm summer of 1959 proved to be very good, showing a mean length of 22.9 cm and reaching a maximum length of 31 cm. The 1959 year-class seems to be the richest one during the most recent years, and this will be reflected on the plaice fishery in the western Baltic in the future by increasing catches.

Flounder

Only the catches in February yielded flounders in remarkable quantities, as they leave the deeper water after spawning.

Dab

The number of dab caught per 1 hour's fishing remained remarkably constant in the course of the year 1960. The 1958 year-class dominated by 54—62 specimens per hour. Already in October 1959, this year-class proved to be rich. The following 1960 year-class is poorly represented in the catches from October 1960, 11 per hour against 136 of the same age-group in the previous year, and therefore it may be considered as below normal. The growth of the dab is fairly good, although not so rapid as that of the plaice. In October, the II-group had reached an average length of 21.5 cm for males and 23.2 cm for females, the III-group 24.9 and 27.1 cm respectively.

Long rough dab

As in the two preceding years, a number of *Drepanopsetta platessoides* were caught, 32 specimens in February, 2 in June, and 3 in October. Obviously pelagic young stages of this species were transported by the strong inflow of water from the north mentioned above; 26 individuals belonged to the 1959 year-class, 8 to the 1960 year-class, 3 to older ones. In May and October 1959, 9 fish of the 1959 year-class and no less than 123 of the 1958 year-class were found in the catches with the standard trawl. These figures indicate the strong fluctuations in the stock of this species in the western Baltic.

Gobiidae

In the autumn and winter 1959/60, large shoals of *Aphya pellucida* mixed with some *Chrystallogobius nilssonii* were recorded in the Kiel Bay.

R. Kändler

Table 18. Numbers of 0- and I-group plaice and flounder, 0-group brill and sole caught per hour with the Johansen young-plaice trawl with iron chain in July/August 1960

(Preliminary figures. In parentheses long-term averages)

	Number of stations	Plaice 0-gr.	Plaice I-gr.	Flounder 0-gr.	Flounder I-gr.	Brill 0-gr.	Sole 0-gr.
Belts	36	39 (84)	64	0.2 (1)	6	0.1	1
Sound	14	75 (84)	35	0 (15)	16	2	31

Flatfish

Investigations on Young Flatfish in Coastal Waters and on Plaice in Open Waters, 1960

(Tables 18–19)

From Table 18 it is seen that the frequency of the 1960 year-class of plaice was about half the normal in the Belts and about normal in the Sound. On the remainder of the north coast of Seeland the strength was also normal, but in Laholm Bay and Skälderviken 0-group plaice occurred numerously. The occurrence of I-group plaice was high in the Belts and over normal in the Sound, in conjunction with the abundance of 0-group fish found there in 1959.

The frequency of the 1960 year-class of flounder was very low. In the report for the Near Northern Seas (p. 104) it is noted that this year-class was also very poor in the Laholm Bay and Skälderviken. In the Belts and the Sound, I-group flounder were more abundant than normal, although rather few 0-group fish were found on the coasts of these waters in 1959. In the Sound they occurred almost exclusively in the southernmost part, the Køge Bay. The 0-group flounder, especially, prefers more muddy bottom than is the case where most of the fishing experiments are carried out.

The numbers of 0- and I-group turbotwere very low, as they have been in most years. In the Belts the 0-group brill was even more sparse, it was, however, more plentiful in the southern part of the Sound (3 per 60 min. haul). Six I-group brill per 60 min. haul were found in the same region. In the Annales Biologiques, Vol. XVI, it was recorded that 0-group brill was unusually plentiful in 1959 in the southern Kattegat.

The 0-group sole was found in low numbers in the Belts, but in rather high numbers in the Sound.

The routine coastal investigations were also carried out at Bornholm but the results are not yet worked up.

The stock of plaice in the open sea

From the age and length distributions shown in Table 19 it is seen that I- and II-group plaice of the rich 1959 and 1958 year-classes were predominant in the Belt Sea as was also the case in 1959 when they originated from the rich 1957 and 1958 year-classes. The total density in 1960 was higher than in 1959 because the 1959 year-class was stronger than the other two. The low numbers of group III and older fish result from the intensive fishery which, together with the natural mortality, every year reduces any number of commercial fish by about 80%. It is seen that the number of plaice over the Danish size limit forms a very small portion of the total stock, and it is evident that it would pay to raise the commercial size limit, which is now 26 cm.

In the western Baltic the hauls made at less than 15 m depth were too few for estimating the numbers present at these depths. In depths over 15 m the numbers were about ten-fold those present in 1959 owing to a large immigration of plaice from less than 15 m depth, especially fish from the rich 1958 and 1959 year-classes. It is evident that some of the age determinations are incorrect, in that most of the plaice caught in August were ascribed to the II-group; in December, however, they were determined as belonging to the I-group, although the average length was about 2—3 cm higher in December, corresponding to the combined effect of the growth of a year-class during this interval of time (about 4 cm), and of the fishery which takes a large portion of the plaice when they have passed the commercial size limit.

In the Sound the plaice under the Danish size limit are almost exclusively confined to depths less than about 15 m where investigations have not been carried out. The numbers of plaice over the commercial size limit and of III-group fish and older present in the Sound are as usual considerably higher than in other areas because trawling is prohibited.

In the region of Møen, the western part of the Baltic proper, the relative amount of plaice over the size limit is also higher than in the Belts and the western Baltic because immigrations of large plaice from the Sound are profitable to the stock.

At Bornholm the plaice in over 33 m depth were mostly 26—30 cm long, whereas in 1959 they were mostly 21—30 cm long. The change is explained by the fact that in both years the stock belonged

Table 19. Number of plaice caught per hour in standard trawl hauls, 1960
(Preliminary figures for age. Length measurements to the nearest lower whole cm)

	Depth, m	Numbers of stations	Age-groups 0	I	II	III	IV	V	VI	VII+	Total
Belts											
July–Sept.	5—14	4	—	18	106	2	—	—	—	—	125
	15—24	21	0.3	70	46	5	0.7	—	—	—	122
	>25	23	—	6	7	3	0.8	0.3	—	—	17
Nov.–Dec.	5—14	9	2	57	56	13	0.9	—	—	—	129
	15—24	19	1	23	27	14	2	0.5	—	—	67
	>25	15	—	29	18	11	3	0.5	0.1	—	62
Western Baltic											
August	15—24	3	—	—	63	7	5	0.7	—	—	75
December	15—24	2	—	44	7	4	—	—	—	—	55
	25—31	3	—	13	7	3	2	—	—	—	25
The Sound											
March–May	15—24	5	—	—	—	3	2	1	2	3	11
	>25	3	—	—	—	5	7	1	3	0.7	17
Sept.–Nov.	15—24	6	—	—	0.3	11	2	—	—	—	14
	23—35	5	—	0.8	2	21	2	2	1	0.4	29
Western part of Baltic proper											
Aug.–Sept.	15—24	5	—	1	2	3	—	—	—	—	6
	>25	5	—	6	3	11	—	—	—	—	20
At Bornholm	33—47	9	—	—	5	3	0.2	0.2	—	—	8
	73—100	7	—	—	4	2	0.3	—	—	—	6

			Length groups, cm 6–10	11–15	16–20	21–25	26–30	31–35	36–40	41–45	46–50	Total
Belts												
July–Sept.	5—14	4	—	5	87	29	4	—	—	—	—	125
	15—24	21	—	6	58	49	9	0.4	—	—	—	122
	>25	23	—	0.4	5	5	5	1	0.4	0.3	—	17
Nov.–Dec.	5—14	9	0.7	9	54	52	12	0.4	0.4	—	—	129
	15—24	19	—	3	23	31	9	1	—	—	—	67
	>25	15	—	12	21	18	8	3	0.8	—	—	62
Western Baltic												
August	15—24	3	—	1	12	37	18	5	1	—	—	75
December	15—24	2	—	1	2	15	29	5	2	1	—	55
	25—31	3	—	0.7	5	10	7	3	—	—	—	25
The Sound												
March–May	15—24	5	—	—	—	0.4	2	2	2	1	2	11
	>25	3	—	—	—	3	7	3	3	1	—	17
Sept.–Nov.	15—24	6	—	—	—	—	4	7	3	0.3	—	14
	23—35	5	—	—	0.4	1	9	11	5	2	1	29
Western part of Baltic proper												
Aug.–Sept.	15—24	5	—	—	1	1	2	2	—	—	—	6
	>25	5	0.4	2	1	5	8	3	—	—	—	20
At Bornholm	33—47	9	—	—	—	1	5	2	0.2	—	—	8
	73—100	7	—	—	—	1	4	2	—	—	—	6

mainly to the 1957 and 1958 year-classes. It has been recruited by fish of the 1958 year-class, but at the same time the numbers have been reduced by fishing and natural mortality by about 80% resulting in a density of about half the strength of that in 1959.

AA. J. C. JENSEN

Investigations on Flatfish Fry off the Coasts of the Southern Baltic in the Period 1954—1960

(Tables 20–22)

Investigations on the number of flatfish fry are carried on along the coast of the southern Baltic in summer. The fry are caught by means of a hand frame trawl, the so-called "push-net". It was pushed along the sandy sea bottom for a given time at a depth of 0.5—1.5 metres when the sea was calm. The fry caught within various periods of time (3—6 min.) was estimated per one hour's haul. Sampling was conducted at the stations in Krynica

Morska (Stat. 1), Gdynia (Stat. 2), Wladyslawowo (Stat. 3), Ustka (Stat. 4), Kolobrzeg (Stat. 5), and Miedzyzdroje (Stat. 6).

Flounder (*Pleuronectes flesus* L.), plaice (*Pleuronectes platessa* L.), and turbot (*Rhombus maximus* L.) were taken in the catches. Dabs (*Pleuronectes limanda* L.) were not found in the near-coastal zone in spite of the fact that this species does appear in the catches and that it is spawning all over the southern Baltic.

The flatfish fry originate from the spring spawning in the Bornholm Basin, Slupsk Furrow and Gdansk Basin regions. Fry of age-group 0 approach the heated coastal waters in the summer when they are several months old and concentrate at a depth from about 50 cm to 1.5 m.

Table 20. Number of O-group flounder caught per hour with the hand push-net

Year	Depth, m	Stations 1	2	3	4	5	6	1–6
		Number of fishes						
1954	0.5–1.5	10	82	202	8	21	96	70
1955	0.5–1.5	8	68	4	0	0	0	13
1956	0.5–1.5	8	168	4	40	12	20	42
1957	— —	—	—	—	—	—	—	—
1958	0.5–1.5	17	142	0	52	90	12	52
1959	0.5–1.5	5	268	20	20	46	16	62
1960	0.5–1.5	70	162	115	18	86	65	86
1954–1960	0.5–1.5	20	148	58	23	42	35	54

Table 21. Number of O-Group plaice caught per hour with the hand push-net

Year	Depth, m	Stations 1	2	3	4	5	6	1–6
		Number of fishes						
1954	0.5–1.5	0	0	0	0	36	218	85
1955	0.5–1.5	0	0	0	4	0	12	5
1956	0.5–1.5	0	0	0	16	4	28	16
1957	— —	—	—	—	—	—	—	—
1958	0.5–1.5	0	0	0	52	93	53	66
1959	0.5–1.5	0	0	0	53	50	76	60
1960	0.5–1.5	0	0	0	0	58	53	37
1954–1960	0.5–1.5	0	0	0	21	40	73	45

Table 22. Number of O-group turbot caught per hour with the hand push-net

Year	Depth, m	Stations 1	2	3	4	5	6	1–6
		Number of fishes						
1954	0.5–1.5	4	12	4	20	32	4	12
1955	0.5–1.5	20	36	20	24	36	36	28
1956	0.5–1.5	8	0	0	8	0	0	3
1957	— —	—	—	—	—	—	—	—
1958	0.5–1.5	48	30	0	36	102	30	41
1959	0.5–1.5	10	0	10	5	33	16	12
1960	0.5–1.5	26	0	15	17	39	15	19
1954–1960	0.5–1.5	19	13	8	18	40	17	19

The purpose of these investigations is to compare the recruitment to the stock of flatfish in the particular years in order to estimate, to a certain extent, the number of fish present after 3—4 years.

The number of fry caught per hour's haul is presented in Tables 20—22.

When comparing the density of the fry of the various species off the eastern and western coasts of the southern Baltic it is apparent that these regions differ as regards the productivity of the year-classes. This is linked with the peculiarity of the spawning grounds and their locality. The greatest number of flounder is found in the eastern region (Stations 2 and 3); the numbers decrease towards the west and make way for the plaice. The absence of plaice in the eastern region can be explained by the fact that the spawning ground of this species is in the western part of the Baltic, namely, in the Bornholm Deep. Fry of flounder occurder more abundantly in the secluded places on the inner side of the Hel Peninsula than in the open sea.

Z. Reimann

Investigations on Demersal Fish in the Gdansk Bay in the Years 1958/1960

(Figures 15–16; Table 23)

During the years 1958/60 standard trawl catches were made with the research vessel "Ewa II". The following cruises were conducted in the respective years: three cruises in June, July, and October of 1958; three cruises in March, April, and June of 1959; and four cruises in February, April, September, and December of 1960.

The catches were taken in the Puck Bay, on the outside of the Hel Peninsula and near the mouth of the River Vistula. Cod and flounder appeared most numerously in the catches, there were, however, only small numbers of plaice and turbot. The results of the catches per hour's trawling are presented in Table 23. The length composition of the catches is shown in Figure 15 for cod and in Figure 16 for flounder.

Table 23.

Year	Number of cruises	Number of hauls	Number of fish per 1 hr. of trawling: Cod	Flounder	Plaice	Turbot
1958	3	38	216.6	7.6	2.2	0.1
1959	3	51	275.1	10.5	1.4	0.1
1960	4	50	276.7	147.9	3.5	1.1

In the years 1958 and 1960 the catches of cod taken by the standard trawl were mostly composed of juvenile fish, 5—34 cm in length, whereas in 1960

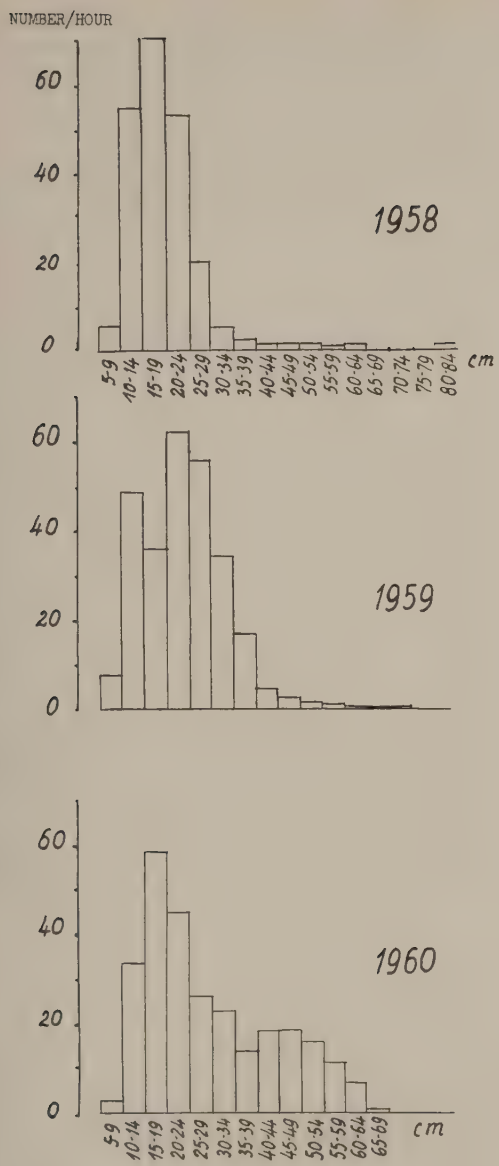

Figure 15. Length composition of cod catches.

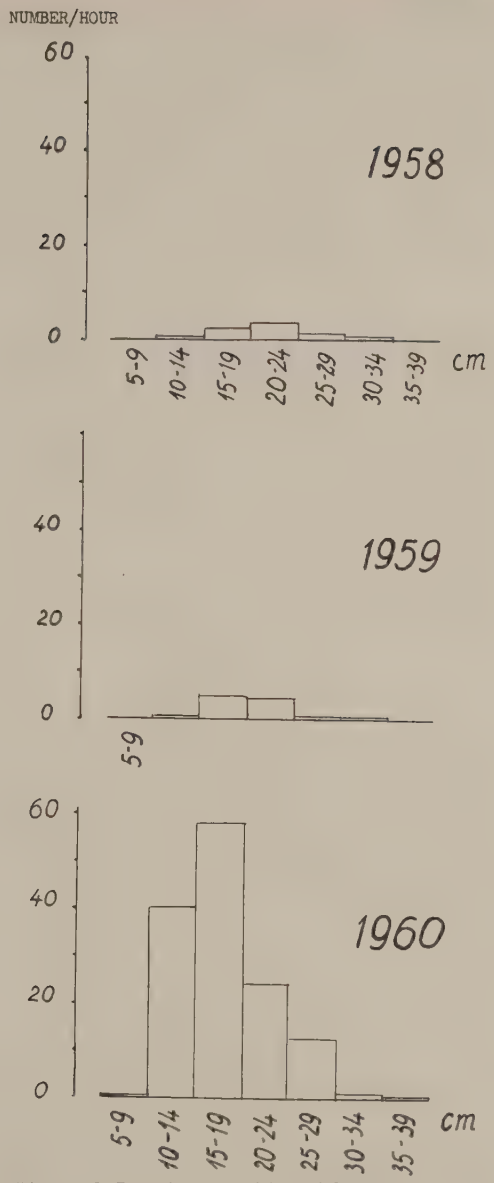

Figure 16. Length composition of flounder catches.

there was a marked increase in the number of fish over 40 cm in length, that is, older fish.

The fish of 10—24 cm in length were predominant in the 1958 catches and they belonged mostly to the 1957 year-class, which is considered to be good. The graph in Figure 15 presenting the yield per hour's trawling in 1959 has two peaks, one at 10—14 cm, the other at 20—34 cm. The first and partly the second peak represent the 1958 year-class, the greatest part of the second peak represents, however, the 1957 year-class. Although the total number of fish caught per hour's trawling is higher in 1959 than it was in 1958, owing to the numerous 1957 and 1958 year-classes, it is con-

cluded that the 1958 year-class is inferior in strength to the 1957 year-class.

The trawling experiments performed in 1960 gave the best results, viz. 276.7 specimens per hour's trawling. There was a rather low number of juvenile fish, 5—24 cm in length, hatched in the years 1959 and 1960. On the other hand, the number of older fish, 40—64 cm in length (1956 and 1957 year-classes), increased as compared with former years. According to the above it may be justified to consider the 1957 year-class of cod as good.

The numbers of flounder caught per hour in the years 1958/59 were not high, amounting to 7.6 and 10.5 fish respectively. In 1960, however, this number was about 15 times greater than in the two previous years, amounting to 147.5 individuals. On the basis of the length composition of the flounder catches in 1958/60 it may be judged that these years were favourable for the development of this species in Gdansk Bay. Recently, the number of juvenile fish has also increased.

J. Netzel

Composition of the Polish Flounder Catches in the Southern Baltic in 1960

(Figure 17; Table 24)

The Polish flatfish catches taken in the southern Baltic in 1960 have shown a further increase in the landings, which was already observed in 1959.

The total landings of this fish amounted in 1960 to 1,631 tons in comparison with 1,403 tons in 1959, and 948 tons in 1958. The catches of flatfish were made in the coastal region by means of hooks and anchored gill nets and in the areas further from the coast by means of trawl in conjunction with the cod fishery.

Table 24. Age composition of the Polish flounder catches (%)

Region	Number of fish	Age-groups II	III	IV	V	VI	VII	VIII+
Gdansk Bay	847	10.4	42.4	24.5	13.5	5.3	2.7	1.2
Bornholm Basin	1074	2.1	37.4	40.9	14.4	3.5	1.2	0.5

According to H. Janko's calculations, the average yield of flatfish per one cutter per day in 1960 was 8.7 kg, in comparison with 6.5 kg in 1959, and 4.5 kg in 1958. As usual, the flounder catches predominate composing over 75% of the landings of flatfish.

The length composition of the flounder catches is shown in Figure 17. In the Gdansk Bay this length oscillated between 18 cm and 46 cm with an annual mean of 26.9 cm, while in the Bornholm Basin it oscillated between 20 cm and 45 cm, the annual mean amounting to 27.6 cm.

The age composition of the flounder is given in Table 24. The catches taken in the Gdansk Bay contain younger fish than those taken in the Bornholm Basin. Flounder belonging to age-group II constituted in Gdansk Bay 10.4%, while this group in the Bornholm region only made up 2.1%. The proportion of age-group III in the Gdansk Bay (42.4%) is also higher than in the Bornholm region (37.4%).

This phenomenon may be caused partly by the difference in the commercial size limit for the

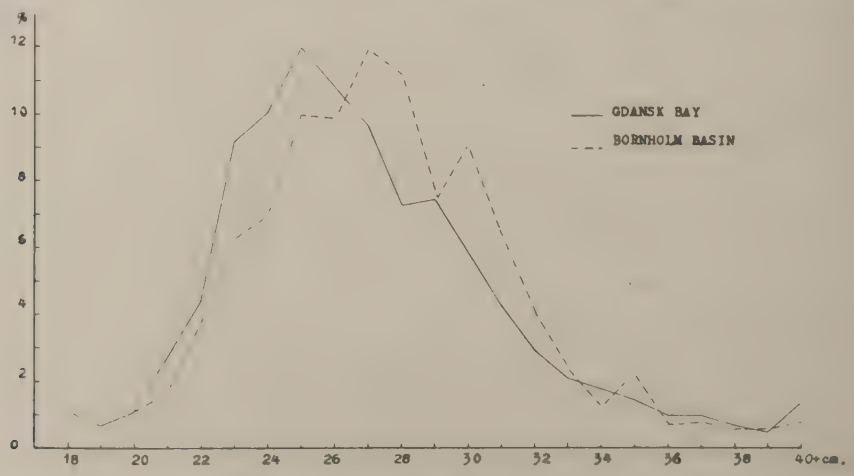

Figure 17. Length composition of the Polish flounder catches (%).

flounder which in the Gdansk Bay is lower than in the Bornholm Basin, and partly by a more intensive exploitation of the flounder stock in the Gdansk Bay.

When comparing the length and age composition of the flounder caught in the Gdansk Bay during 1960 with that from the last two years (Ann. Biol., XVI, p. 112) an insignificant increase in the annual mean length and age of the fish may be noticed.

W. Cieglewicz

The Stock of Flounder in the Central Baltic

(Figures 18–19; Tables 25–26)

The flounder of the Baltic Sea (*Pleuronectes flesus trachurus* D.) may serve as an example of a relatively sparse population with a narrow range of yearly fluctuations.

The limited spawning and feeding areas and easy vulnerability to fishing make the study of the biological characteristics of the flounder population especially important for the proper understanding of the regularities that govern the fluctuations in the stocks.

The analyses of the age, size, and weight composition of the flounder stock have shown that in the catches taken in the period 1957 to 1960 the predominant groups were the 4 and 5 year-old fish, the younger groups yielding but poor recruitment (Table 25). During these years the average size composition by age-groups have not shown any substantial changes.

Table 25. Age composition of the flounder catches taken in the Ventspils area

Year	Age (years) 2	3	4	5	6	7	8	Number of fish
1957	—	9.8	51.8	29.6	7.3	1.3	0.2	400
1958	0.2	8.2	50.2	36.7	4.4	0.3	—	500
1959	0.1	19.2	39.1	29.8	10.8	0.7	0.3	500
1960	—	20.0	47.1	27.1	5.0	0.8	—	400

Table 26. Average length (cm) and weight (g) by age of the flounder in the Ventspils area in July/August

Year	Age (years) 1	2	3	4	5	6	7	Number of fish
			Length (cm)					
1957	—	—	18.3	20.2	22.7	24.9	26.1	400
1958	—	14.1	18.4	20.3	22.4	24.0	25.8	500
1959	—	17.1	19.6	22.4	22.4	25.3	—	500
1960	—	—	19.1	21.3	23.0	24.0	—	400

	Weight (g) 12	14	16	18	20	22	24	26	28
1957	64	90	111	142	184	250	300	370	
1958	—	77	116	142	186	227	267	360	

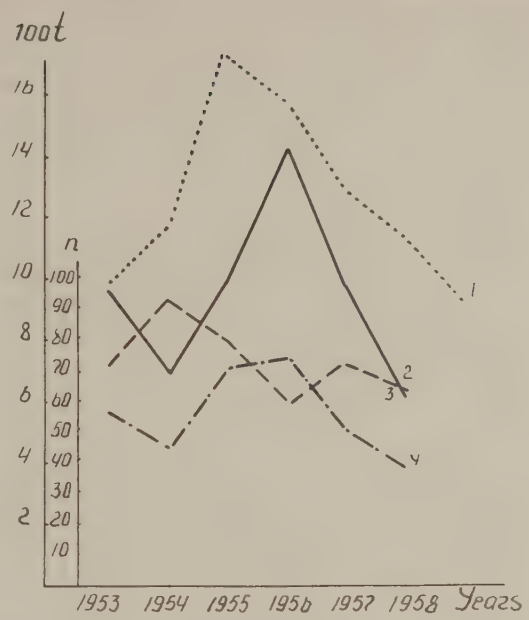

Figure 18. Catches of flounder in the waters of the Latvian Republic (in 100 tons).

Fishing for flounder in the coastal waters of the Latvian and Estonian SSRs is mainly conducted by motor boats using 'snurrevods'. Flounder also constitute a by-product of the trawl catches of the fishing fleets of the Lithuanian SSR and Baltic State Fishing Trust (Kaliningrad).

As seen from Figure 18, the Latvian catches of flounder have shown a decrease during the last ten years, fluctuations, however, being less pronounced. Thus, the greatest catch during this period was observed in 1952 when 1,670 tons were taken, a yield which was only twice as high as the lowest one of 800 tons obtained in 1948.

The data available on the fluctuations in the exploitation of flounder in this area over a period of several years help to understand the stock/fishing interrelationship.

The catches of flounder in the Ventspils area are representative enough for understanding the fluctuations for the whole Latvian Republic. When distributing the data over the number of commercial fishing units operating in the area it was possible to calculate the catch per fishing effort (Fig. 19).

The value of the total catch was not affected by the changes in the number of motor boats engaged in the fishing operations over the period in question; catch per fishing effort corresponded to the total value of the catch.

Figure 19. Fluctuations in the flounder catches and catch per unit of effort.

Consequently, catches of flounder during these years were mainly determined by the size of the stock, in spite of a vulnerability to fishing due to a sedentary, demersal mode of life of this species. Both this peculiarity and a relatively small reproductive capacity, together with limited fluctuations of abundance, call for a cautious way of exploiting this particular stock.

Recent year-classes of flounder were not particularly abundant, the stock remaining at a relatively stable and low level. The catches of 1958/59 reveal, however, a decreasing trend owing to poor recruitment. Catch per fishing effort is also declining. All these factors call for a careful management of the stocks; a proper regulation of fishing for flounder, especially important in case of this inactive species, requires strict observation of a biologically founded commercial size limit.

K. A. Zemskaya

Silver-Eel

As in previous years, the forecast of the yield of silver-eels was given on the basis of the temperature of the surface waters during the summer. The yield was expected to be normal or somewhat below normal. Actually, the catches taken in the Belts and the Sound were 23% over those of the last 9 years (when the methods of collecting statistics were improved and the minimum size for silver-eels was suspended). In the western Baltic the catch was about normal but in the Baltic proper, a region which for this fishery comprises only the Baltic coasts of Seeland, Møen, and Falster, it was 50% over normal. From the reports of the fishery control, it appears that the yield was especially high on the eastern coasts, but in many cases it was poor on other coasts. The fact that the total catches were very much higher than expected according to the summer temperatures, may be partly due to the extraordinary prevalence of eastern winds.

The frequency of the tumour disease was approximately the same as in the preceding year.

Aa. J. C. Jensen

Sturgeon

Sturgeon (*Acipenser sturio* L.) caught in the Firth of Vistula

On the 20. April 1960 the fishermen from Katy Rybackie, a place on the coast of the Firth of Vistula, caught a huge specimen of *Acipenser sturio* L., intertwined in fish nets.

The fish was a female of a total length of 288 cm. The girth width measured round the belly was 114 cm, the width of the head was 106 cm, and round the tail at the basis of the caudal fin it measured 34 cm. The total weight was 117 kg, the roe itself weighing 13.7 kg.

After the belly was cut open, no remainders of any food were found in the intestines. The sturgeon was at stage V of maturity according to the Maier scale, and thus it had appeared in the Firth of Vistula undoubtedly in connection with the spawning season which generally starts in April and ends in June.

Because *Acipenser sturio* is completely absent from the Polish rivers it has been subjected to full protection, and capture of this species deserves punishment; this specimen was, however, already dead when taken from the nets.

The skin of the fish is now deposited in the Museum of the Sea Fisheries Institute at Gdynia.

In consideration of both this registration of an occasional catch of sturgeon and the existing literature on the subject, it must be admitted that our specimen was the largest one among all those caught in the Baltic since 1943. A similar, but somewhat smaller, specimen of sturgeon was found in June 1944 in the River Mala Nevka near Leningrad. Its total length and weight were 225 cm and 77 kg respectively.

St. Kujawa

Lamprey

Some Data on the Catches and Population Dynamics of Lamprey (*Lampetra fluviatilis* L.) in the Rivers of the Latvian SSR

(Tables 27–29)

Catches of lamprey in the Latvian SSR are subject to great annual fluctuations. The size of the catch is determined solely by the stock variations because the success of the fishery during the fishing

season is not influenced by the hydrological conditions.

Almost no data can be found in the literature concerning the factors governing the population dynamics of the lamprey. For this reason an analysis was made of the correlation between the size of the catch, the hydrometerological conditions, and the size of the parental stock.

Analysis of the data for 46 years has, however, not revealed any correlation between the catches of parents and offspring of lamprey in the rivers of Latvia (the analysis was conducted separately for each probable average age of the spawning stock — from 4 to 8 years).

In order to evaluate the environmental conditions, the indices of air temperature and river discharge were used for the periods from 1 to 8 years before the year in which the given catch was taken. In this way the whole potential life span of the lamprey would be covered.

Environmental data were analysed for each quarter of the year with due consideration of the most important stages in the life history of the lamprey.

Distinct correlations were found only between the catches and the air temperature in the second and third quarters, 5 to 6 years prior to the year of the given catch (Table 28). In other aspects of the analysis the correlations are either doubtful or non-existent.

The data analysed permitted of drawning the following conclusions:—

1. The size of the catch (success of the fishery) does not depend on the weather conditions during the fishing season.

2. The life span of the majority of the lamprey caught in Latvia is 5 to 6 years.

3. No correlation was found for the period in question between the number of parents and that of descendants.

4. The abundance of the year-classes of lamprey is influenced by the conditions of spawning and incubation; rich year-classes are formed during warm spring seasons (Table 28, air temperature in the second quarter, 5—6 years prior to the catch).

5. The abundance of the year-classes is also influenced by the living conditions of the one summer-olds and yearlings in the feeding period (Table 28, air temperature in the third quarter); in cool summers young ammocoete keep close to the river banks on grounds which are rich in detritus; with increasing air and water temperatures the larvae move to deeper waters where the feeding conditions are bad, and the probability of being devoured by predators is greater.

6. The correlations shown in paragraphs 4 and 5 are independent and causal for each case: Table 29 confirms this conclusion.

7. Wintering conditions have apparently little effect on the mortality rates of larvae of any one age; the same holds good for the feeding conditions of 3—4 year-old larvae.

8. The abundance of the lamprey is apparently less influenced by environmental conditions during the metamorphosis and the sea period than during the early stages of development.

N. I. Ryapolova

Table 27. Catches of lamprey in the Latvian SSR

Year	Kg	Year	Kg
1948	15,800	1955	73,000
1949	21,600	1956	73,100
1950	20,900	1957	108,100
1951	16,300	1958	106,500
1952	73,400	1959	103,600
1953	100,200	1960	88,000

Table 28. Correlations between catches of lamprey and air temperatures in quarters II and III (46 years of catches on the Gauya River and 47 years on the Daugava River)

	Quarter II						Quarter III					
Air temperature	6 years before catch			5 years before catch			6 years before catch			5 years before catch		
Catch	+	av.	—	+	av.	—	+	av.	—	+	av.	—
+	25	5	19	26	4	17	19	7	20	17	6	22
av.	1	1	0	1	0	0	0	1	0	1	0	0
—	18	2	25	14	3	30	24	5	15	25	7	13

+ = Temperature and catch above long-term average.
av. = Temperature and catch at average level.
— = Temperature and catch below long-term average.

Table 29. Correlation between air temperatures (°C) in quarters II and III (For 66 years of observations)

Quarter II	Quarter III		
	+	av.	—
+	15	3	11
av.	3	0	3
—	12	3	16

+ = above normal
av. = average
— = below normal

Pike-perch

Pike-perch (*Lucioperca lucioperca* (L.))

(Table 30)

In 1960, 1660 pike-perch caught on the spawning grounds in the Bay of Pärnu were analysed. Length, weight, age, maturity stage, food content, and fatness were determined. In the commercial catches from the Bay of Pärnu the rich 1954 year-class was predominant in 1960 as well as in the previous years. The majority of the pike-perch attain sexual maturity at an age of five years (Table 30).

Table 30. Length and age (‰) of pike-perch

Length			*Age*	
cm	May–June Spawning	Year-class	Age	May–June Spawning
38	25	1949	11	1
39	43	1950	10	3
40	65	1951	9	2
41	113	1952	8	3
42	145	1953	7	51
43	157	1954	6	677
44	118	1955	5	261
45	113	1956	4	2
46	82	Total		1000
47	49			
48	30			
49	17			
50	22			
51	9			
52	3			
53	6			
54	2			
55	1			
Total	1000			

V. Erm

Silver Bream

Silver Bream (*Abramis vimba* or *Vimba vimba* (L.))

(Table 31)

In 1960, 1030 analyses of *Vimba vimba* caught in the Pärnu River and the Bay of Pärnu were carried out. Length, age, maturity stage, food content, and fatness were determined. Analyses for age in the spawning population indicated that the broods of 1950 and 1952 were comparatively rich. In the Pärnu River the 1952 year-class was predominant in the spawning populations, but the commercial catches taken in the Bay of Pärnu consisted mainly of younger age-groups. In the Bay of Pärnu the vimba attain sexual maturity mainly at an age of 6–7 years (Table 31).

Table 31. Length and age (‰) of silver bream

Length			*Age*			
cm	May–June Spawning	Oct.–Nov. Autumn	Year-class	Age	May–June Spawning	Oct.–Nov. Autumn
22	—	108	1944	16	2	0
23	—	196	1945	15	2	1
24	14	234	1946	14	10	1
25	50	151	1947	13	22	3
26	107	120	1948	12	59	5
27	194	77	1949	41	67	9
28	140	36	1950	10	151	22
29	124	24	1951	9	159	31
30	102	18	1952	8	415	61
31	98	14	1953	7	106	136
32	63	9	1954	6	7	458
33	48	5	1955	5	—	273
34	30	4		Total	1000	1000
35	18	2				
36	6	2				
37	2	—				
38	2	—				
—	—	—				
41	2	—				
Total	1000	1000				

V. Erm

Gadoid Fish

INTRODUCTION

Contributions to this report have been received from the following:--

Denmark:
P. M. Hansen

Germany:
Arno Meyer
D. Sahrhage
J. Messtorff

Iceland:
Jón Jónsson

Norway:
E. Bratberg

Poland:
St. Rutkowicz

Scotland:
R. Jones
R. Gambell

U.S.S.R.:
A. S. Baranenkova
I. A. Lablaika
M. A. Sonina

U. Schmidt

YOUNG STAGES

Greenland

Cod Fry and Small Cod in Coastal Waters and on the Offshore Banks of West Greenland in 1960

(Figures 1–2)

Occurrence of cod eggs

In the period January/June, hauls with the 1 m stramin net were made in the Godthåb Fjord area, both surface (100—50 m wire out) and deep water (400, 500, and 600 m wire out). In January/February no cod eggs were caught.

The first cod eggs were captured on 16. March in the inner part of the fjord near the most important spawning place. In hauls with 100—50 m wire out and 400 m wire out, 46 and 45 cod eggs were taken respectively.

On 11. April, 803 and 77 cod eggs were taken in the same locality with 100—50 and 400 m wire out respectively; this was the greatest number of cod eggs taken in this fjord in 1960. Thus the number of cod eggs caught in the Godthåb Fjord area was rather small in 1960, just as in 1959.

In the coastal area of Godthåb, too, few cod eggs were taken, the best haul (100—50 m wire out) containing 140 cod eggs.

On 30. April, three hauls (100—50 m wire out) were made on the Fylla Bank section. Forty-six cod eggs were taken between the bank and the coast, 22 over the middle of the bank, and 3,457 eggs over the western slope of the bank. On the latter station 545 cod eggs and 5 larvae were captured in a haul with 600 m wire out.

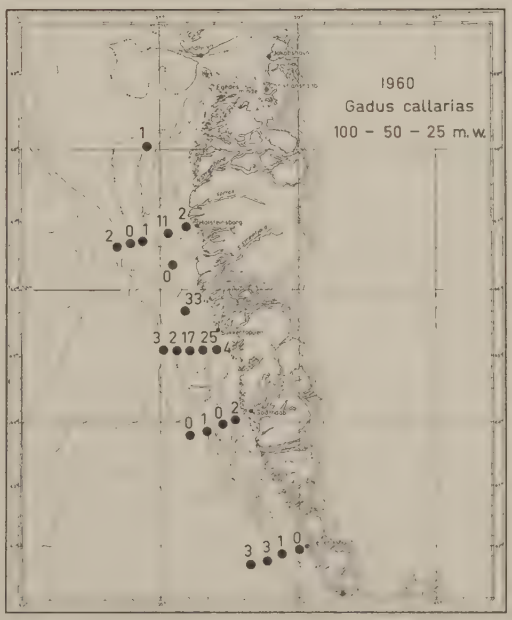

Figure 1. Catches of cod larvae in a 30 min. haul with the 2 m stramin net.

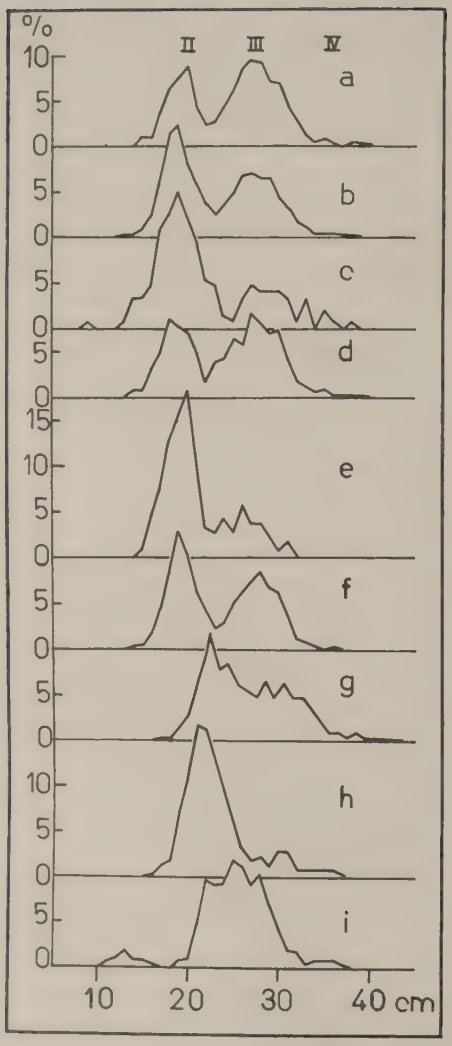

Figure 2. Length distribution of small cod in coastal areas.

Occurrence of cod fry

Owing to engine trouble the "Dana" could not work in Greenland waters in 1960. Investigations in the Davis Strait in July therefore had to be carried out from the cutters "Adolf Jensen" and "Sujumut". On four of the sections, hydrographical observations and hauls with 2 m stramin net were made; the hauls were made with only 100—50 m wire out. From the small vessels it was impossible to work the westernmost stations normally worked by the "Dana" (Fig. 1). On the southernmost section the occurrence of cod fry was more plentiful than in most of the previous years. The greatest numbers were encountered between 65° and 66°N Lat. At the different stations, however, the number of cod larvae taken was not particularly great. Prediction of the importance of the 1960 year-class is rather difficult; it is, however, not likely that this year-class will be considered rich, but probably a medium one.

Occurrence of small cod of age-groups I, II, and III

Nine samples of small cod of age-groups I—III were collected in 1960. The length frequencies are given in Figure 2. Samples a—h were all taken in the area south of Godthåb (about 64°N); sample i was from the harbour of Christianshåb (about 68°50′N) and samples a—f were from catches with shrimp trawl (ca. 250 m depth) taken in January, February, and March. Samples g, h, and i were caught with hand-seine on the shore in June, July, and August.

Age-group I (1959 year-class) occurred only sparsely in samples a, c, and i and was not represented in the other samples.

Age-group II (1958 year-class) was, however, strongly represented in all samples, which is rather surprising owing to the fact that this year-class during the preceding year was present only in a single sample, taken in area 1 F.

Age-group III (1957 year-class) was strongly represented in all samples except in h. This year-class was also plentiful in the samples in 1958 and 1959. Otoliths of 199 cod (sample a) were taken for age determination. The mean lengths of cod belonging to age-groups II and III were 20.1 cm and 27.6 cm respectively.

P. M. Hansen

Soviet Investigations on Small Cod of Age-Groups 0, I, II, and III in the Barents Sea

(Tables 1–3)

A quantitative analysis of small cod was carried out during the autumn/winter of 1959/60 in the southern part of the Barents Sea from the R. V. "Tunetz" and "Persey II", and in the northwestern part from "Tunetz" and the trawler "Melitopol". As in previous years the sampling was made with the 25 m bottom trawl with covered cod-end and a mesh size of 10 mm between the knots.

Southern areas

The results of the analyses are given in Table 1. The average catch of small cod, 0—3+ years old, taken per hour's trawling in the southern part of the Barents Sea in the autumn/winter season of 1959/60 was 36 fish. No pronounced difference was

Table 1. Mean number of young cod of different ages caught per hour's trawling in the southern Barents Sea

Area	Month of sampling	Number of hauls	Age and year-class 0+ (1) 1959	1+ (2) 1958	2+ (3) 1957	3+ (4)[1] 1956	Total	Total number of fish
Central	Oct.–Feb.	168	18	11	20	10	59	9,935
Western	Oct.–Feb.	247	8	4	9	5	26	6,513
Coastal	Oct.–Feb.	68	10	8	7	1	26	1,803
Eastern	Nov.	45	2	15	7	3	27	1,234
North-eastern	Nov.	27	1	1	1	1	3	94
Central Elevation	Oct.–Feb.	29	14	13	23	8	57	1,656
Total		584	11	8	11	6	36	21,235
% of total			29.4	22.1	33.0	15.5		

[1]) This group includes only specimens below 36 cm length.

found in the number of small cod of the various year-classes, cod of the 1959 and 1957 year-classes were, however, more abundant than those of the 1956 and 1958 year-classes.

The 1959, 1957, and 1956 year-classes were predominant in the central areas and in the Central Elevation area; in the eastern areas I-group fish were more abundant. In the north-eastern areas young cod of all age-groups were scarce.

The 1959 year-class was widely distributed throughout the southern part of the Barents Sea. Some fish of this age-group occurred in the trawl catches farther north than 75°N. Several specimens were caught in the eastern part of the sea at 57°48′E.

The greater abundance of 0-group cod (1959 year-class) in the central areas, and especially in the northern part, suggested that the drift of small cod in 1959 occurred in the main branch of the North Cape Current. However, further eastward this group was not observed. Judging by the average catch per hour's trawling (14 fish) the

Table 2. Mean number of 1–4 year-old cod caught per hour's trawling in the southern Barents Sea during autumn/winter

Year-classes	1 year-old	2 year-old	3 year-old	4 year-old	Mean catch of 2 and 3 year-olds
1946	1	2	7	8	5
1947	2	8	23	5	17
1948	18	28	21	31	25
1949	5	14	34	26	24
1950	14	89	77	70	82
1951	16	20	8	3	13
1952	1	1	3	2	2
1953	4	11	11	4	11
1954	30	14	6	15	10
1955	7	1	9	2	4
1956	12	15	9	6	12
1957	31	4	11	—	10
1958	11	8	—		—
1959	11	—	—	—	—
Long-term mean excl. 1950 year-class	11	10	12	9	11

Table 3. Mean number of young cod caught per hour's trawling in the north-western Barents Sea from September 1959 to January 1960

Areas	Month of sampling	Number of hauls	Age and year-class 0+ (1) 1959	1+ (2) 1958	2+ (3) 1957	3+ (4)[1] 1956	Total	Total number of fish
Bear Island								
Southern slope	Nov.–Dec.	34	33	26	28	8	95	3,232
Eastern slope	Oct.–Dec.	21	9	29	33	11	82	1,721
Western slope	Sept.–Jan.	49	21	12	11	3	47	2,305
Total		104	23	20	21	6	70	7,251
% of total			32.4	28.6	30.1	8.9		
West Spitsbergen	Sept.–Dec.	59	9	24	14	3	50	2,915
South Cape Gully	Sept.–Jan.	30	30	19	24	7	80	2,414
Hopen	Oct.–Nov.	27	8	8	10	5	31	842
Perseus Elevation	Oct.	17	4	1	1	1	7	85
Western Gully	Oct.	11	4	11	6	1	22	238
Total of all areas		248	12	13	11	4	40	13,741
% of total			30.0	31.9	29.4	8.7		

[1]) This group includes only specimens below 36 cm in length.

abundance of 0-group cod in the Central Elevation area approximated the numbers of the 0-group of the 1958 year-class (16 specimens), the 1953 year-class (15 specimens), and the 1950 year-class (14 specimens).

Table 2 shows the mean number of young cod of different ages taken per hour's trawling. A comparison with the long-term mean data shows the year-classes of 1956, 1957, and 1958 to be moderately abundant. The 1959 year-class cannot be estimated to be above average.

North-western areas

In the winter of 1959 the total mean number of small cod of different age-groups caught per hour's trawling over all the areas of the NW Barents Sea was somewhat higher than in the southern part of the sea (see Table 3, 40 as against 36 spec.). On the slopes of the Bear Island Bank and in the South Cape Gully the mean number of cod belonging to the 1959, 1958, and 1957 year-classes caught per hour's trawling exceeded more than twice that taken in the southern part of the sea. In the Bear Island region and in the southern part of the Barents Sea the mean catches of 1956-class cod were similar.

Judging by the mean catches taken in the different areas of the NW Barents Sea, it is evident that 0-group cod (1959 year-class) were less numerous in the West Spitsbergen area and in the Hopen area than on the southern and western slopes of the Bear Island Bank and in the South Cape Gully. The 0-group was especially scarce on the Perseus Elevation and in the Western Gully. The bulk of small cod was therefore not carried far northward even when drifting with the Spitsbergen Current.

A. S. Baranenkova

German Investigations on Arcto-Norwegian Cod and Haddock

(Tables 4–5)

The R. V. "Anton Dohrn" has for the first time been fishing for small cod and haddock using a herring cod-end, the interior of which was covered with 12 mm cotton nets. The number of cod and haddock taken per hour during a cruise at the end of November is shown in Table 4.

Most of the cod belonged to the 1957 and 1958 year-classes, whilst the 1959 year-class of haddock was predominant. The average length of the different age-groups at the end of the feeding period is given in Table 5.

Arno Meyer

Table 4.

Area	Depth (m)	Cod (age-groups) 0	I	II	III	Haddock (age-groups) 0	I	II	III
Skolpen Bank	165–200	21	14	101	180	34	155	82	65
Tiddly Bank	190–200	59	45	125	241	90	121	26	50
Bear Island SE	125–190	10	40	130	256	4	—	—	—
Bear Island SW	170–245	21	19	27	43	—	—	—	—

Table 5.

Area	Cod (cm) age-groups 0	I	II	III	Haddock (cm) age-groups 0	I	II	III
Skolpen Bank	11.1	18.7	30.0	36.8	15.7	24.9	30.4	40.1
Tiddly Bank	10.7	15.5	27.2	37.8	14.9	24.2	30.3	40.3
Bear Island SE	11.6	19.9	29.4	38.0	—	—	—	—
Bear Island SW	11.5	18.9	28.3	39.6	—	—	—	—

COMMERCIAL FISH

COD

Greenland Stock

Cod Investigations in the Coastal Waters and on the Offshore Banks of West Greenland in 1960

(Figures 3–6; Tables 6–9)

1. Age composition

Offshore banks

Otoliths of 3,134 cod were collected on the offshore banks; 1,459 from hand-line catches and 1,675 from long-lines. All catches were taken from "Adolf Jensen" and "Sujumut". The catches were distributed according to subdivisions (see Ann. Biol., **16**, p. 115, Fig. 3) in the following way:—

Subdivision	Hand-lines	Long-lines
1 B	253	291
1 C	555	634
1 D	651	750
1 F	234	830

The stations where the experiments were carried out are shown in Figure 3. Figure 4 shows the age and length distributions. The lengths are given in 5 cm groups. The length distribution curves include aged as well as tagged cod, together with those which were measured only. In order to compare age compositions and length distributions of hand-line and long-line catches both gears were used at eight different stations. From the figures it is evident that the hand-lines yielded younger and smaller cod than did the long-lines. The difference in mean age and length is given in Table 6.

Table 6.

Station No.	Mean Age Long-line	Mean Age Hand-line	Mean Length (cm) Long-line	Mean Length (cm) Hand-line
1	8.08	5.85	79.3	62.6
2	10.69	9.47	79.4	77.0
3	10.06	8.28	76.0	—
4	8.65	8.01	75.1	73.9
8	9.52	6.86	75.7	68.2
10	10.11	8.31	83.4	78.1
11	11.60	9.74	83.3	79.9
12	10.94	8.12	73.2	68.9

It appears from Table 6 that both the mean ages and the mean lengths are higher for cod taken on long-lines than for those taken on hand-lines. Age-groups younger than group V constitute on an average 29% in the hand-line catches and only 11.2% in the long-line catches.

Inshore waters and fjords

From the coastal area and the fjords, 4,613 cod taken in 24 catches were aged. The results are shown in Figures 5 and 6.

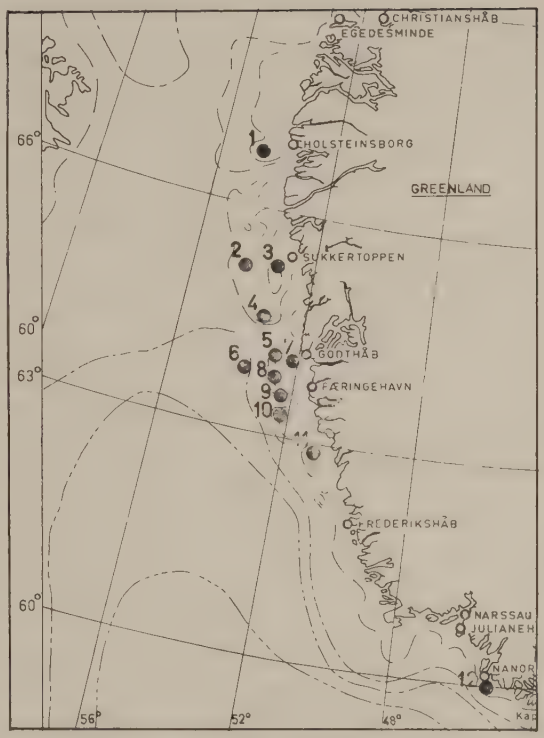

Figure 3. Localities on offshore banks in which otolith samples were collected for age analyses. The numbers correspond with those given in Figure 4 and Table 6.

According to subdivisions the samples were distributed as follows:—

Subdivision	No. of sample
1 A	13, 14
1 B	15, 16, 17
1 C	no samples
1 D	18, 19, 23—36
1 E	20, 21
1 F	22

The 1947 year-class predominated only in two samples (13, 29) while in all other samples, No. 22 excepted, it constituted less than 20%.

The 1953 year-class was strongly predominant in a sample from subdivision 1 A (No. 14) and in the samples from the northern part of 1 B (Nos. 15, 16). This year-class was also well represented in samples from the coastal region in subdivision 1 D where it was predominant in Nos. 26, 30, and 31; it was, however, very poorly represented in the inner

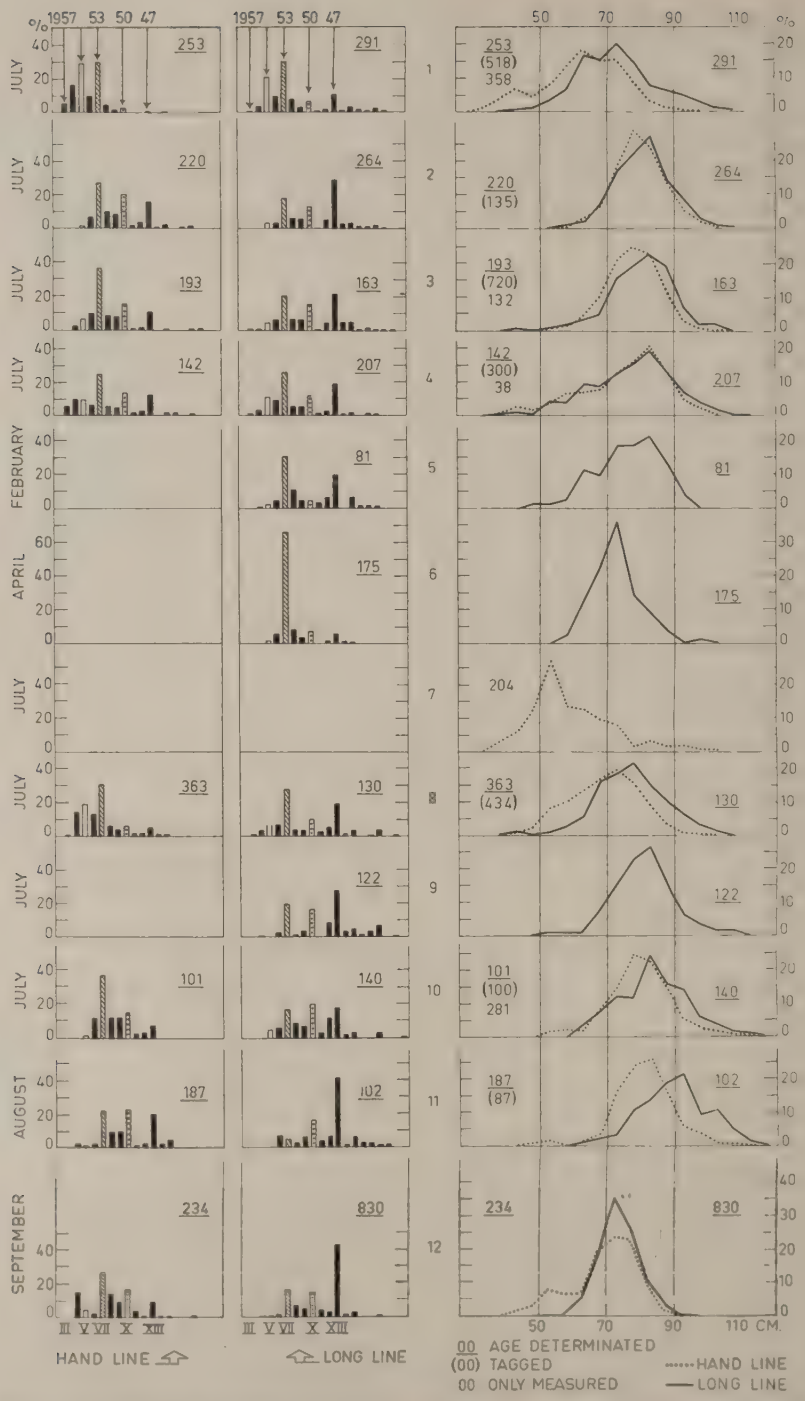

Figure 4. Percentage age and length distribution of cod from the West Greenland banks in 1960.

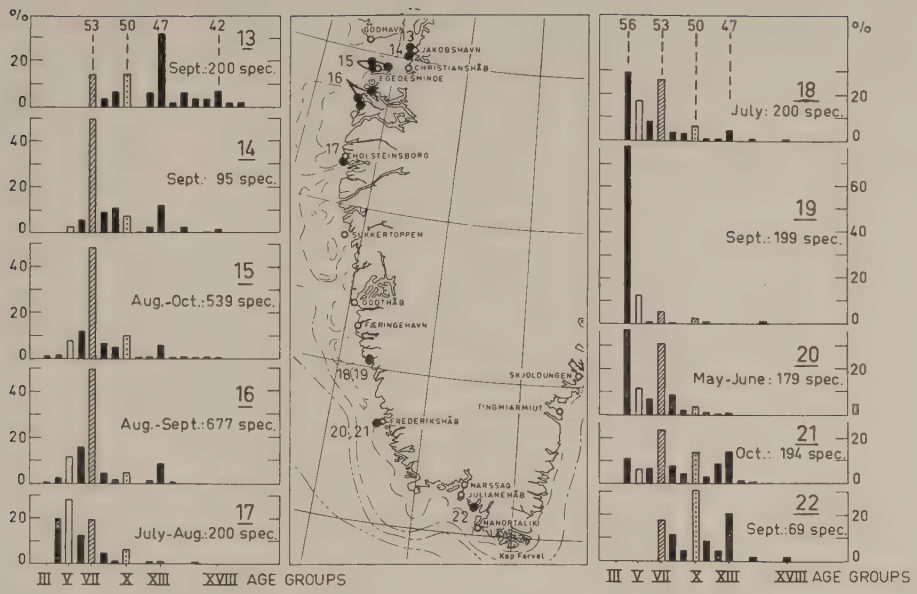

Figure 5. Percentage age distribution of cod from north and south of the Godthåb district in 1960.

Figure 6. Percentage age distribution of cod from the Godthåb district in 1960.

Table 7. Age composition and mean lengths of male and female cod taken on the West Greenland banks in 1960

Year-class	Age-group	Sample Nos. 1 Store Hellefiske Bank 66°40′N, 54°25′W 25.–26. July, 45–135 m Long-line Nos.	cm ♂♂	cm ♀♀	Sample Nos. 1 Store Hellefiske Bank 66°40′N, 54°25′W 25.–26. July, 50 m Hand-line Nos.	cm ♂♂	cm ♀♀
1957	III	1	42.0	—	13	43.4	40.9
1956	IV	9	51.3	50.0	41	53.6	52.4
1955	V	62	60.1	61.1	74	61.0	60.5
1954	VI	28	63.8	67.6	25	64.3	67.9
1953	VII	86	70.6	71.5	76	70.3	74.1
1952	VIII	21	74.3	75.7	11	74.0	75.4
1951	IX	7	76.3	76.0	4	—	77.3
1950	X	19	75.8	81.2	6	80.0	83.7
1949	XI	1	—	80.0	—	—	—
1948	XII	4	79.0	90.0	—	—	—
1947	XIII	30	83.1	89.8	2	81.0	92.0
1946	XIV	3	—	90.0	—	—	—
1945	XV	8	80.5	86.0	1	87.0	—
1944	XVI	5	89.7	94.5	—	—	—
1943	XVII	1	—	95.0	—	—	—
1942	XVIII	5	86.5	100.0	—	—	—
1941	XIX	1	—	96.0	—	—	—
Total number		291			253		

Year-class	Age-group	Sample Nos. 2 Lille Hellefiske Bank 65°06′N, 54°02′W 15. July, 80–100 m Long-line Nos.	cm ♂♂	cm ♀♀	Sample Nos. 2 Lille Hellefiske Bank 65°06′N, 54°02′W 14. July Hand-line Nos.	cm ♂♂	cm ♀♀
1955	V	10	62.5	64.0	3	61.0	67.0
1954	VI	10	68.2	70.5	15	69.6	71.7
1953	VII	48	72.0	76.0	59	74.0	76.6
1952	VIII	17	74.7	80.0	22	78.5	76.5
1951	IX	16	76.3	82.3	18	77.8	82.3
1950	X	36	77.6	82.5	44	80.5	82.8
1949	XI	1	78.0	—	4	82.5	98.5
1948	XII	14	84.4	85.1	8	82.8	90.0
1947	XIII	78	82.0	83.9	35	81.4	85.7
1946	XIV	8	79.3	85.0	1	—	94.0
1945	XV	9	85.8	87.3	6	87.0	—
1944	XVI	5	82.5	89.7	—	—	—
1943	XVII	4	86.7	89.0	1	83.0	—
1942	XVIII	6	88.6	94.0	4	89.0	93.5
1941	XIX	1	—	97.0	—	—	—
1939	XXI	1	—	93.0	—	—	—
Total number		264			220		

Godthåb Fjord where the 1952 year-class was predominant in samples Nos. 33, 34, and 35. Outside the Godthåb Fjord the 1952 year-class was poor. In the two samples from subdivision 1 E the 1953 year-class was strongly represented in No. 22 and predominant in No. 23.

The 1955 year-class was abundant in some samples from the Godthåb Fjord. In a sample taken in the inner part of the fjord (No. 36) it dominated at about 30%, and in another sample (No. 33) from the same place it amounted to about 22%.

Table 7 (continued)

Year-class	Age-group	Sample Nos. 3 Lille Hellefiske Bank 65°07′N, 53°15′W 23. July, 80–130 m Long-line			Sample Nos. 3 Lille Hellefiske Bank 65°07′N, 53°15′W 24. July Hand-line		
		Nos.	cm ♂♂	cm ♀♀	Nos.	cm ♂♂	cm ♀♀
1957	III	1	42.0	—	—	—	—
1956	IV	1	50.0	—	4	50.7	55.0
1955	V	8	62.5	62.7	13	61.6	61.8
1954	VI	10	64.7	69.3	19	66.2	69.8
1953	VII	33	73.4	74.7	70	75.2	74.5
1952	VIII	11	78.0	79.3	16	79.6	81.1
1951	IX	10	80.3	81.7	15	80.0	82.4
1950	X	25	79.4	85.1	29	77.6	81.9
1949	XI	1	—	83.0	1	76.0	—
1948	XII	7	83.4	85.0	2	—	80.0
1947	XIII	35	84.1	86.6	21	80.4	84.6
1946	XIV	8	79.5	90.7	—	—	—
1945	XV	7	—	94.9	1	98.0	—
1944	XVI	1	—	102.0	—	—	—
1943	XVII	2	93.0	—	—	—	—
1942	XVIII	1	—	92.0	1	—	97.0
1941	XIX	1	—	118.0	1	88.0	—
1940	XX	1	—	125.0	—	—	—
Total number		163			193		

Year-class	Age-group	Sample Nos. 4 Banana Bank 64°25′N, 53°13′W 13. July, 60–100 m Long-line			Sample Nos. 4 Banana Bank 64°25′N, 53°13′W 12.–13. July Hand-line		
		Nos.	cm ♂♂	cm ♀♀	Nos.	cm ♂♂	cm ♀♀
1957	III	4	42.5	42.0	8	41.4	42.0
1956	IV	7	51.7	53.0	14	52.0	48.7
1955	V	23	59.4	59.2	14	60.4	59.8
1954	VI	19	66.3	66.6	9	67.8	65.0
1953	VII	53	72.5	77.2	35	76.0	75.8
1952	VIII	11	76.9	81.0	8	78.5	82.5
1951	IX	11	81.0	77.8	7	82.5	81.0
1950	X	24	85.0	84.2	19	85.6	84.2
1949	XI	3	86.0	86.5	2	86.0	88.0
1948	XII	6	80.3	89.3	4	89.5	89.5
1947	XIII	38	87.2	90.6	17	85.0	92.6
1946	XIV	2	—	84.0	—	—	—
1945	XV	3	90.0	98.0	2	85.0	87.0
1944	XVI	—	—	—	2	—	91.0
1943	XVII	2	—	91.5	—	—	—
1942	XVIII	1	82.0	—	1	—	85.0
Total number		207			142		

Table 7 (continued)

Sample Nos.		5			6		
		Fylla Bank 64°03′N, 52°28′W 20. February, 90–125 m Long-line			Fylla Bank 63°58′N, 53°28′W 30. April, 85–150 m Long-line		
Year-class	Age-group	Nos.	cm ♂♂	cm ♀♀	Nos.	cm ♂♂	cm ♀♀
1956	IV	1	46.0	—	—	—	—
1955	V	2		50.0	2	57.5	—
1954	VI	4	60.0	62.3	10	63.2	62.8
1953	VII	25	67.6	67.8	115	67.0	71.1
1952	VIII	9	72.0	79.5	14	73.0	77.0
1951	IX	4	77.0	80.0	6	72.7	79.0
1950	X	5	73.3	79.5	12	80.0	81.7
1949	XI	3	79.5	81.0	—		—
1948	XII	5	79.0	81.3	2	85.0	83.0
1947	XIII	16	79.8	82.9	10	81.3	82.7
1946	XIV	—		—	2	88.0	80.0
1945	XV	5	85.0	91.5	1	—	81.0
1944	XVI	1	—	70.0	—		—
1943	XVII	1	86.0		—		—
1942	XVIII	1	81.0	—	—	—	—
1934	XXVI	—	—		1	—	98.0
Total number		81			175		

Sample Nos.		8			8			9		
		Fylla Bank 64°01′N, 52°26′W 9. July, 150 m Long-line			Fylla Bank 64°01′N, 52°26′W 4.–5. July, 150–180 m Hand-line			Fylla Bank 63°41′N, 52°24′W 30. July, 70–100 m Long-line		
Year-class	Age-group	Nos.	cm ♂♂	cm ♀♀	Nos.	cm ♂♂	cm ♀♀	Nos.	cm ♂♂	cm ♀♀
1957	III	1	—	41.0	2	43.5	—			—
1956	IV	4	59.7	54.0	51	55.0	54.1	1	—	52.0
1955	V	10	63.8	62.0	67	62.8	63.1			—
1954	VI	9	66.3	68.6	47	64.7	68.0	3	68.0	67.5
1953	VII	36	71.7	74.4	112	72.0	73.9	24	73.1	73.2
1952	VIII	5	—	76.8	20	75.1	77.8	2	68.0	68.0
1951	IX	4	74.0	73.7	12	76.3	82.0	4	82.5	79.5
1950	X	13	85.0	84.2	20	76.3	81.0	20	79.1	85.4
1949	XI	3	86.0	—	4	86.0	92.0		—	—
1948	XII	7	73.7	81.5	5	74.0	82.0	10	80.8	82.8
1947	XIII	25	80.2	83.3	17	78.6	82.2	34	81.3	85.9
1946	XIV	2	79.5	—	3	80.5	83.0	4	79.5	83.5
1945	XV	4	—	88.0	3	—	92.7	5	91.0	101.0
1944	XVI	—	—					2	—	87.0
1943	XVII	1	86.0	—	—	—	—	4	83.5	72.5
1942	XVIII	5	89.3	100.0	—	—	—	8	82.6	99.0
1940	XX	1	72.0	—	—	—	—	1	73.0	—
Total number		130			363			122		

Table 7 (continued)

Year-class	Age-group	Sample Nos. 10 Fiskenæs Bank 63°28′N, 52°08′W 8. July, 60–80 m Long-line			Sample Nos. 10 Fiskenæs Bank 63°28′N, 52°08′W 9. July Hand-line		
		Nos.	cm ♂♂	cm ♀♀	Nos.	cm ♂♂	cm ♀♀
1955	V	6	65.5	62.0	1	—	58.0
1954	VI	8	67.7	69.6	12	69.0	68.0
1953	VII	23	73.8	73.4	37	74.3	75.9
1952	VIII	12	79.0	76.0	12	78.6	79.3
1951	IX	9	82.3	84.2	12	85.7	85.9
1950	X	27	83.5	88.4	15	86.3	83.5
1949	XI	4	81.5	83.0	2	—	79.5
1948	XII	16	87.3	86.8	3	85.0	85.0
1947	XIII	24	88.7	93.7	7	94.0	87.7
1946	XIV	2	89.0	97.0	—	—	—
1945	XV	4	98.0	88.0	—	—	—
1942	XVIII	4	99.0	103.0	—	—	—
1939	XXI	1	—	86.0	—	—	—
Total number		140			101		

Year-class	Age-group	Sample Nos. 11 Dana Bank 62°49′N, 51°09′W 5. August, 60–80 m Long-line			Sample Nos. 11 Dana Bank 62°49′N, 51°09′W 5. August Hand-line		
		Nos.	cm ♂♂	cm ♀♀	Nos.	cm ♂♂	cm ♀♀
1956	IV	—	—	—	5	53.0	51.3
1955	V	—	—	—	2	59.0	60.0
1954	VI	7	63.8	68.0	5	68.0	69.7
1953	VII	5	74.5	69.0	40	72.5	76.9
1952	VIII	3	70.0	72.0	17	76.1	77.8
1951	IX	6	77.5	88.0	18	81.0	82.1
1950	X	16	77.2	85.6	42	80.1	86.7
1949	XI	4	—	90.3	3	82.0	99.0
1948	XII	7	88.2	88.0	5	89.7	87.0
1947	XIII	41	86.3	89.8	37	82.2	83.9
1946	XIV	1	78.0	—	5	83.3	77.0
1945	XV	6	98.0	83.3	8	84.5	88.5
1944	XVI	2	85.0	100.0	—	—	—
1943	XVII	2	96.5	—	—		—
1942	XVIII	1	—	127.0	—	—	—
1941	XIX	1	—	89.0	—	—	—
Total number		102			187		

Table 7 (continued)

Year-class	Age-group	Sample Nos. 12 Kitsigssut 60°03′N, 45°10′W 30. Sept.–4. Oct., 115 m Long-line Nos.	cm ♂♂	cm ♀♀	12 Kitsigssut 60°03′N, 45°10′W 23.–30. Sept. Hand-line Nos.	cm ♂♂	cm ♀♀
1956	IV	6	49.0	47.0	33	52.1	50.4
1955	V	4	53.0	53.0	10	56.8	57.0
1954	VI	9	63.7	63.0	5	65.0	61.3
1953	VII	132	66.7	67.4	62	67.8	68.5
1952	VIII	55	69.7	71.8	31	71.0	73.4
1951	IX	41	73.7	73.7	21	73.9	74.5
1950	X	124	74.7	78.6	38	77.1	78.2
1949	XI	34	76.6	78.6	8	80.0	77.4
1948	XII	25	73.2	74.3	1	—	79.0
1947	XIII	353	73.5	75.7	21	76.1	77.8
1946	XIV	10	72.0	77.7	1	71.0	—
1945	XV	23	75.9	76.5	1	60.0	—
1944	XVI	1	—	83.0	—	—	—
1943	XVII	2	82.0	91.0	—	—	—
1942	XVIII	7	81.0	85.3	2	82.5	—
1940	XX	3	—	89.0	—	—	—
1936	XXIV	1	—	116.0	—	—	—
Total number		830			234		

Table 9. Age at first maturity of the 1947 year-class of Greenland cod in 1960

Coastal area north of 63°N

Age	No. ♂♂	‰	No. ♀♀	‰
6	7	68	8	62
7	42	408	41	318
8	42	408	52	403
9	10	97	26	202
10	2	19	2	16
Total	103		129	
Mean age		7.5		7.8

Coastal area south of 63°N

Age	No. ♂♂	‰	No. ♀♀	‰
6	8	308	3	214
7	11	423	6	429
8	6	231	4	286
9	1	38	—	—
10	—	—	1	71
Total	26		14	
Mean age		7.0		7.3

Banks off the west coast

Age	No. ♂♂	‰	No. ♂♂	‰
6	76	169	17	46
7	235	523	167	453
8	115	256	154	417
9	20	45	29	79
10	1	2	2	5
11	2	4	—	—
Total	449		369	
Mean age		7.2		7.5

The 1956 year-class was predominant in seven samples, three from the mouth of Godthåb Fjord (Nos. 24, 25, and 28), one from the central part of that fjord (No. 32), two from the southern part of subdivision 1 D (Nos. 18 and 19), and one from subdivision 1 E (No. 20). In two other samples (Nos. 27 and 28) from the mouth of Godthåb Fjord, the 1956 year-class constituted more than 30%.

The rich 1957 year-class has not yet entered the commercial fishery. In a hand-line catch taken at the mouth of Godthåb Fjord this year-class was predominant at 56.7%.

2. Maturity

Age at first maturity was determined by means of the otoliths of all aged, mature cod. A more comprehensive material of such determinations is only available for the 1947 year-class. The age at first maturity for this year-class is shown in Table 9. The data are given separately for the following regions: coastal area north of 63°N, coastal area south of 63°N, and the West Greenland banks. It appears from the table, and also from previous data. that males as a rule mature earlier than females.

3. Tagging experiments

In 1960 a total of 4,575 cod were tagged in West Greenland waters. Of these, 2,882 cod were tagged on the offshore banks and 1,693 in coastal waters

Table 8. Age composition from inshore waters and fjords of West Greenland in 1960

Year-class	Samples Age-group	13 Sept.	14 Aug. Sept.	15 Aug. Sept. Oct.	16 Aug. Sept.	17 July Aug.	18 July	19 Sept.	20 May June	21 Oct.	22 Sept.	23 Apr.	24 Apr.
1957	III	—	—	4	4	8	—	—	—	—	—	—	35
1956	IV	—	—	6	16	41	58	154	66	21	—	6	53
1955	V	—	2	41	76	57	35	24	20	13	—	25	17
1954	VI	—	5	63	105	25	17	2	12	13	—	25	8
1953	VII	28	47	261	337	39	52	11	55	45	12	25	11
1952	VIII	7	8	35	28	10	7	1	15	15	8	9	5
1951	IX	13	10	27	9	2	6	—	3	8	3	4	1
1950	X	29	7	54	30	13	13	5	6	27	21	9	—
1949	XI	—	—	3	2	—	1	1	1	5	6	2	—
1948	XII	12	2	3	7	2	1	—	—	17	3	2	—
1947	XIII	63	11	31	56	2	8	—	1	27	14	7	—
1946	XIV	3	—	1	5	—	—	—	—	2	—	2	—
1945	XV	12	2	4	—	—	1	—	—	1	1	2	1
1944	XVI	7	—	1	—	1	—	1	—	—	—	—	—
1943	XVII	7	—	3	1	—	—	—	—	—	—	1	—
1942	XVIII	13	1	2	1	—	1	—	—	—	1	1	1
1941	XIX	3	—	—	—	—	—	—	—	—	—	—	—
1940	XX	3	—	—	—	—	—	—	—	—	—	—	—
Total number		200	95	539	677	200	200	199	179	194	69	120	132

Year-class	Samples	25 June	26 July	27 July	28 Sept.	29 Oct.	30 Nov.	31 Nov.	32 Apr.	33 Feb.	34 Feb.	35 Feb.	36 Apr.
1957	III	13	1	68	124	2	7	7	4	—	—	—	—
1956	IV	167	4	96	72	7	5	1	41	5	—	—	—
1955	V	24	4	17	14	8	8	15	12	53	3	3	38
1954	VI	5	4	7	4	19	5	5	6	20	—	3	6
1953	VII	7	20	5	2	24	19	31	2	11	17	2	10
1952	VIII	1	16	2	3	7	9	16	3	59	52	32	27
1951	IX	2	3	1	—	7	6	3	—	7	3	2	3
1950	X	1	12	—	—	31	14	16	2	21	20	16	18
1949	XI	—	—	—	—	1	3	1	1	9	10	10	6
1948	XII	1	3	—	—	6	2	5	—	9	7	4	3
1947	XIII	1	6	2	—	37	9	24	—	16	15	6	7
1946	XIV	—	2	—	—	2	—	1	—	2	2	1	1
1945	XV	—	1	—	—	3	2	3	—	10	17	6	4
1944	XVI	—	—	—	—	—	—	2	—	1	3	—	1
1943	XVII	—	—	—	—	—	—	2	—	1	4	2	1
1942	XVIII	—	1	—	—	2	2	4	—	7	9	4	—
1941	XIX	—	—	—	—	—	—	—	—	1	1	1	—
1940	XX	—	1	—	—	—	—	2	—	3	9	2	1
1939	XXI	—	—	—	—	—	—	—	—	1	1	2	—
1938	XXII	—	—	—	—	—	—	—	—	—	1	—	—
Total number		222	78	198	219	156	91	138	71	236	174	96	126

and the fjords. The distribution according to subdivisions was as follows:—

Subdivision	Offshore banks	Coastal waters and fjords
1 B	611	—
1 C	1105	—
1 D	1147	866
1 E	19	—
1 F	—	432

White Petersen discs were used for all taggings carried out on the banks. In the coastal waters and the fjords 731 cod were also tagged with the Petersen discs, while 545 fish were tagged with hydrostatic tags and 43 with red plastic tags.

Information on recaptures from these taggings is at present not available.

P. M. Hansen

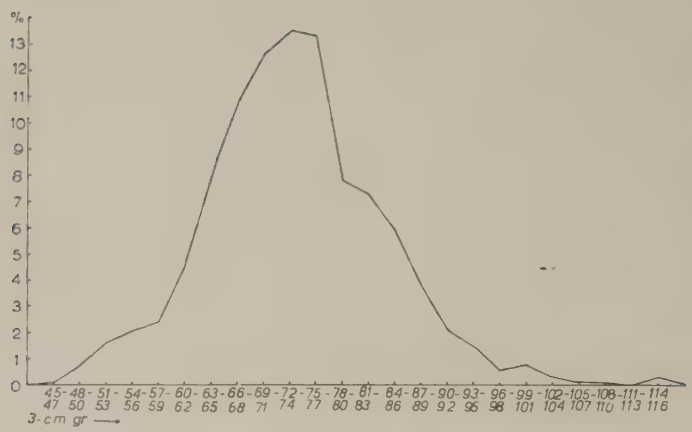

Figure 7. "G. O. Sars", West Greenland, April 1960. Length distribution of cod. Total catch, bottom long-lines.

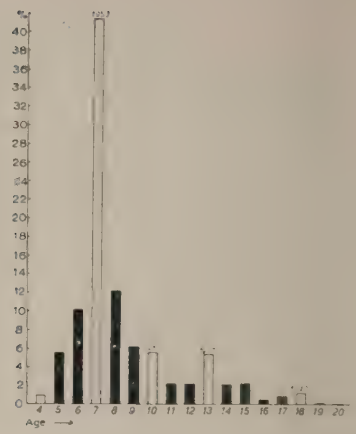

Figure 8. "G. O. Sars", West Greenland, April 1960. Age composition of cod. Total catch, bottom long-lines.

Norwegian Investigations off West Greenland

(Figures 7–10; Tables 10–12)

The echo-sounder survey indicated a different distribution of cod than that of April 1959. In contrast to the foregoing year no cod were registered over the deeper parts of the western slopes of the banks, although the temperature was 4° C or over. On the other hand, this year also fish were encountered only on the top of one bank, namely the central part of Lille Hellefiske Bank. A few successful registrations with the echo-sounder showed that the cod were largely staying in waters of temperature between 2° and 4° C. This was also confirmed by the fishing experiments (Tables 10 and 11). These tables also indicate that the temperature limit for spawning might be lower than 4° C, the limit found there before. This is, however, not the case as the cod were at a different stage of maturity than in 1959; the greater part of the mature cod had already completed spawning (see Table 12). Only 10.5% of the fish were actually in spawning condition while 11.2% were still maturing.

Figures 7 and 8 show the length distribution and age composition of the bottom long-line catches. Relatively small cod are predominant in the long-line catches but a good deal of them are properly sized for the Norwegian commercial fisheries. The mean length for the total long-line catch is 73.3 cm. The age composition of the cod taken with bottom long-lines shows that the rich 1942, 1947, and 1950 year-classes do not play an important part in the catches any longer. Altogether these year-classes provided only 12.8% of the total catch. The 1953 year-class was strongly predominant and constituted 43.1% of the total long-line catch.

In Figures 9 and 10 the length distribution and age composition for the total trawl catch are shown. As expected, these two diagrams differ much from Figs. 7 and 8, but it must also be borne in mind that the data for the trawl catch are based on only two samples from two different banks. The mean length of the trawl-caught cod is 58.5 cm and the size of almost all the fish in these two samples is far below a good commercial size.

Table 10. "G. O. Sars", West Greenland, April 1960, cod bottom long-line stations

Date April	Position	Depth (m)	Bottom temp. (° C)	Number of hooks	Number of cod caught
5.	61°41′N, 50°39′W	190	3.3	1,800	242
6.	61°29′N, 50°28′W	205	3.1	2,100	197
7.	62°13′N, 50°49′W	140	1.9	1,950	139
12.	65°19′N, 53°42′W	125	3.9	2,050	82
13.	64°12′N, 53°05′W	170	3.2	2,050	41
14.	64°40′N, 54°17′W	155	2.6	1,900	298
22.	63°24′N, 52°44′W	135	1.8	2,050	80
25.	62°32′N, 51°07′W	210	2.3	2,050	110
26.	62°25′N, 50°50′W	200	2.0	2,050	234

Table 11. "G. O. Sars", West Greenland, April 1960, halibut long-line stations

Date April	Position	Depth (m)	Bottom temp. (° C)	Number of hooks	Number of cod caught
5.	61°44′N, 50°39′W	198	3.9	1,000	20
7.	62°12′N, 50°34′W	125	1.7	1,000	51
12.	64°31′N, 53°02′W	108	2.5	925	43
19.	64°14′N, 53°17′W	200	4.5	1,000	1
25.	62°32′N, 51°07′W	210	2.3	1,000	8
26.	62°25′N, 50°50′W	200	2.0	1,000	51

Table 12. "G. O. Sars", West Greenland, April 1960; total catch of cod taken by bottom long-lines and trawl; stage of maturity

Length, cm group	Stage of maturity[1]) 0	1	2	3	4	5	Total
39– 41	2	—	—	—	—	—	2
42– 44	6	—	—	—	—	—	6
45– 47	26	—	—	—	—	—	26
48– 50	49	—	—	—	—	—	49
51– 53	45	—	—	—	—	3	48
54– 56	30	—	—	—	—	1	31
57– 59	27	—	—	1	2	2	32
60– 62	24	—	1	2	9	14	50
63– 65	32	1	2	7	8	29	79
66– 68	29	—	5	12	15	47	108
69– 71	19	—	4	12	22	69	126
72– 74	12	—	5	8	22	90	137
75– 77	10	—	2	15	13	88	128
78– 80	4	—	2	11	3	57	77
81– 83	2	—	—	7	7	51	67
84– 86	4	—	1	1	8	38	52
87– 89	2	—	—	7	2	22	33
90– 92	1	—	—	3	2	14	20
93– 95	—	—	—	—	2	10	12
96– 98	—	—	—	—	1	4	5
99–101	—	—	—	1	—	5	6
102–104	—	—	—	1	—	2	3
105–107	—	—	1	—	—	—	1
108–110	—	—	—	—	—	1	1
114–116	—	—	1	2	—	—	3
Total	324	1	24	90	116	547	1,102

[1] The stages used here is a modification of the stages used by MAIER and modified by SIVERTSEN.

Stage used here	=	Sivertsen stage	=	Maier stage
0	=	1	=	I, II, III
1, 2, 3	=	2	=	IV, V
4	=	3	=	IV
5	=	4	=	VII, VIII

The low mean length in the trawl catch is due to the 1956 year-class having a mean length of 49.0 cm. This year-class does not appear so numerously in the long-line catches due to the different selectivity of the two types of gear. The 1956 year-class seems to be very strong. Its influence on the trawl catch may, however, also be caused by different shoaling on the two banks in question.

Comparing the samples of April 1960 with those of April 1959 it might be expected that the 1947 and 1950 year-classes will be of no importance to the long-line fishery off West Greenland in 1961. The 1953 year-class will still be predominant and probably increase in relative strength. The increasing importance of this year-class may also involve a slight increase in the mean length of the cod taken by long-lines, depending on how the 1956 year-class will influence the long-line fishery.

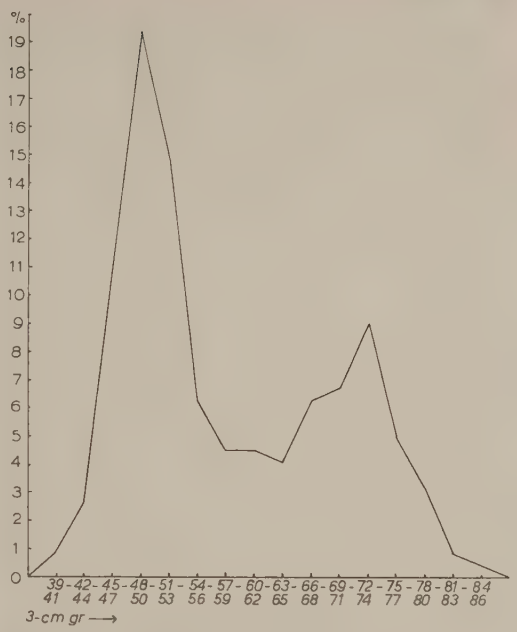

Figure 9. "G. O. Sars", West Greenland, April 1960. Length distribution of cod. Total catch, trawl.

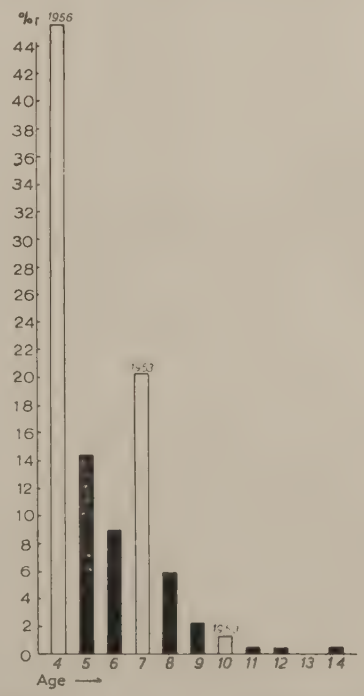

Figure 10. "G. O. Sars", West Greenland, April 1960. Age composition of cod. Total catch, trawl.

Table 13. Length and age composition of West and South Greenland cod in 1960 (‰)

Length, cm	Commercial trawler samples: Fylla/Banana Bank April–July	Noname Bank June	Banana Bank December	"Anton Dohrn" Dana Bank May 280–300 m
30– 34	—	—	—	—
35– 39	—	—	—	—
40– 44	—	—	—	—
45– 49	2	—	9	15
50– 54	16	6	35	41
55– 59	77	18	93	41
60– 64	154	93	258	104
65– 69	240	173	300	212
70– 74	232	226	138	282
75– 79	149	206	105	160
80– 84	67	156	30	90
85– 89	32	61	23	39
90– 94	18	31	4	7
95– 99	7	17	1	7
100–104	3	4	2	—
105–109	2	7	1	2
110–114	1	2	1	—
Average length	70.9	75.3	67.5	71.3
Year-class				
1957	—	—	12	—
1956	32	1	161	7
1955	109	18	396	71
1954	118	70	131	86
1953	512	284	248	345
1952	45	57	23	61
1951	38	87	8	79
1950	58	170	7	138
1949	6	21	—	23
1948	12	43	—	26
1947	51	189	6	131
1946	1	17	3	13
1945	10	27	—	14
before 1945	8	16	5	6

Tagging experiments

Due to the bad weather prevailing on the cruise in April 1960, the tagging programme had to be cut short. Only 107 cod were tagged, all with Lea tags attached by nylon gut in front of the first dorsal fin.

ERLING BRATBERG

German Investigations, 1960

(Figure 11; Tables 13–15)

The 1960 fishery off Greenland yielded the highest landings ever, amounting to 92,393 tons (cod 37.4%, redfish 54.7%). The year 1960 was also the best year for the cod fishery because the landings of cod from East Greenland for the first time were nearly as high as those from West Greenland.

West Greenland

The length distribution and age composition of commercial and research samples are given in Table 13. The 1953 year-class was predominant in almost all the commercial landings as well as in the "Anton Dohrn" samples. Only in spring, on Noname and Dana Banks, the older, now diminishing, 1950 and 1947 year-classes were of commercial importance. The trip of a scouting trawler in April/May gave the best possibilities for studying the proportion of mature cod present on the different fishing grounds and at different depths. In contrast to the foregoing year, German trawlers carried out fishing throughout the winter of 1960/61. In spite of temperatures of more than 20° C below zero a profitable fishery for cod developed on the Fylla and Banana Banks; in March and April 1961, large concentrations of spawning cod were encountered for the first time at depths between 350 m and more than 550 m.

South Greenland

In 1960 there was only little fishing for cod off South Greenland. In the catches taken by a scouting trawler at the beginning of May, the 1956, 1953,

Table 13 (continued)

Research samples, Scouting trawler

Length, cm	Lille Hellefiske Bank April 140–190 m	Fylla Bank April 150–300 m	Fiskenæs Bank April 170 m	Fiskenæs Bank April 230–320 m	Dana Bank April 70–220 m	Nanortalik Bank May 100–270 m
40– 35	20	—	—	—	—	4
30– 34	24	5	—	—	5	18
44– 93	24	—	9	—	52	162
45– 49	44	32	61	—	169	74
50– 54	88	18	167	11	109	42
55– 59	157	55	166	—	56	49
60– 64	13	151	86	34	81	106
65– 69	287	312	148	213	171	137
70– 74	102	239	164	292	183	173
75– 79	766	101	139	157	100	130
80– 84	40	64	34	169	41	70
85– 89	8	9	17	79	28	28
90– 94	8	14	9	34	5	7
95– 99	4	—	—	—	—	—
100–104	—	—	—	—	—	—
105–109	—	—	—	11	—	—
110–114	—	—	—	—	—	—
Average length	63.7	68.8	59.7	75.6	63.3	63.6
Year-class						
1957	56	5	39	—	5	—
1956	78	50	331	9	319	263
1955	297	18	76	2	52	40
1954	158	177	49	64	41	31
1953	327	546	420	519	403	383
1952	18	106	35	44	91	52
1951	19	43	27	119	16	65
1950	27	41	10	93	45	115
1949	—	—	2	10	—	10
1948	—	—	—	—	13	—
1947	8	—	8	62	10	41
1946	—	—	1	13	—	—
1945	8	7	2	54	—	—
before 1945	4	7	—	11	—	—

and 1950 year-classes were predominant (see Table 13). Most of the cod were immature, all mature cod were recovering spents, and no spawning cod were found. From the results of tagging experiments it can be deduced that all these recovering spents must have spawned off SE Greenland. The data in Table 14 show that the cod off South Greenland become mature at a relatively high age.

East Greenland

The catches taken off East Greenland in 1960 rose to 49,421 tons of which more than 15,000 tons were cod.

As in 1959, the rich 1950 year-class was predominant in the landings from Angmagssalik and the Dohrn Bank, but in diminishing proportions (see Table 15). The 1953 year-class was more and more prominent in the fishery, especially off SE Greenland, where fishing is hampered by very rough bottom and often by severe ice conditions.

The spawning of cod off Tordenskjold reached its maximum during the first half of April. The age composition given in Table 15 does not represent the age of the stock of spawners, for 29% of the cod caught off Tordenskjold were immature fish, partly up to 13 years old. Thirty per cent of the 1933 year-class, 24% of the 1950 year-class, and 18% of the 1947 year-class were juveniles. This demonstrates again the late onset of maturity in the East Greenland cod.

Table 14. Proportion of immature and mature cod in the different year-classes off South Greenland, May 1960

Year-class	Age (years)	Immature (%)	Mature (%)
1956	4	100	0
1955	5	100	0
1954	6	100	0
1953	7	89	11
1952	8	88	12
1951	9	82	18
1950	10	77	23
1949	11	60	40
1947	13	27	73

Table 15. Length and age composition of East Greenland cod in 1960 (‰)

	Commercial trawler samples				Research samples Scouting trawler		
	Angmagssalik Jan./Mar.	Tordenskjold Mar./Apr.	Fylkir June/July	Dohrn Bank Sept./Nov.	Discord/Fylkir May	Møsting Bank May	Angmagssalik May
Length, cm							
40– 44	—	—	—	—	—	17	—
45– 49	—	—	12	—	—	14	—
50– 54	—	—	45	—	16	4	12
55– 59	10	3	105	2	—	8	12
60– 64	47	53	160	18	8	29	107
65– 69	123	141	172	42	16	115	190
70– 74	238	245	189	110	72	157	274
75– 79	274	247	146	209	233	236	190
80– 84	202	196	79	239	265	181	119
85– 89	75	79	47	189	162	128	48
90– 94	21	24	30	104	116	61	48
95– 99	8	7	10	56	40	12	—
100–104	1	2	3	16	40	4	—
105–109	1	1	1	6	8	4	—
110–114	—	1	—	—	—	7	—
115–119	—	1	1	—	—	—	—
>119	—	—	—	—	24	23	—
Average length	76.5	76.5	70.5	82.7	85.6	79.0	73.9
Year-class							
1956	—	—	39	17	—	35	24
1955	24	2	53	36	—	—	163
1954	57	22	59	59	16	47	343
1953	200	278	375	268	48	184	187
1952	90	83	171	108	16	71	13
1951	80	105	100	70	87	63	50
1950	278	256	132	314	231	287	207
1949	104	26	15	91	56	33	13
1948	—	38	7	—	40	14	—
1947	—	131	16	—	227	179	—
1946	47	5	3	37	32	10	—
1945	—	40	17	—	119	47	—
before 1945	—	14	13	—	128	30	—

At the beginning of May, very big and old cod were caught by a scouting trawler off the Discord, Bille, and Fylkir Banks. Thirty-eight per cent of the 92% mature fish were still spawning. Off Cape Møsting 65% were immature, in spite of the high mean age of 10.0 years. Of the 1950 and 1947 year-classes 73% and 32% respectively were juvenile fish.

In the by-catch of the redfish fishery carried out off Angmagssalik the 1954 year-class was predominant, a year-class which is well represented off Iceland.

Tagging experiments

From October 1959 to October 1960, 1,728 cod were tagged (yellow DHb plastic tag with yellow or blue-white-red plastic flap) off SE, S, and SW Greenland in order to get more information about the migrations of the south and south-east Greenlandic stock of cod. Up to April 1961, 32 recaptures were reported (Fig. 11). All the cod tagged from October to December 1959 and recaptures from February to June 1960 had migrated against the current from Dana Bank and Semersut (SW Greenland), Nanortalik Bank (S Greenland), and Bille Bank (SE Greenland) to north-western Iceland. A cod tagged off Cape Farewell was probably caught on the Angmagssalik fishing ground. Furthermore 3 cod tagged in May and September 1960 and recaptured from February to April 1961, had migrated in the same direction: from Cape Farewell and Nanortalik Bank to Bille Bank and Tordenskjold Bank, and from Noname Bank to Nanortalik Bank. Due to the fact that all these cod were big fish, 8 to 14 years old and 71 to 92 cm in length, and had migrated in winter and early spring, it is

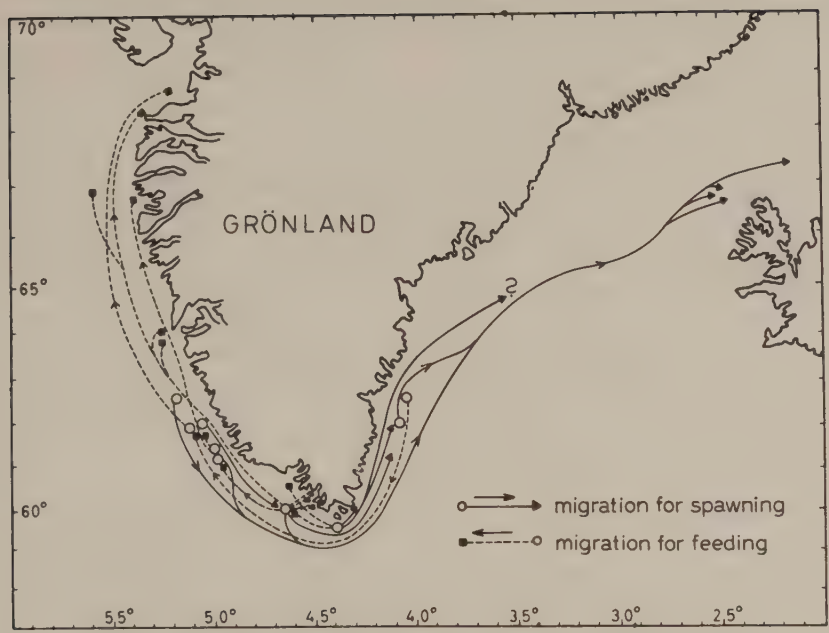

Figure 11. Spawning and feeding migrations of cod tagged off SW, S, and SE Greenland in 1959/60.

presumed that this migration must have taken place with the purpose of spawning off East Greenland or NW Iceland.

All the other recaptures reported after the end of the spawning season showed a migration *with* the current to the feeding grounds off West Greenland. The farthest migrations of cod tagged at the beginning of May 1960 and recaptured from June to September 1960 were from Nanortalik Bank to Fylla Bank and to the northern edge of Store Hellefiske Bank, or from Semersut and Noname Bank to Holsteinsborg and Disco Bay.

Off SE Greenland cod migrated also with the current in early summer. The most rapid was a 94 cm cod which covered a distance of about 430 miles from Fylkir Bank to Noname Bank within 27 days. The long distance feeding migrations were mostly carried out by larger and older cod, whilst the younger cod were mostly recaptured near the tagging locality.

Arno Meyer

Icelandic Stock

The Spawning Stock of Cod in 1960

(Table 16)

Table 16 shows the age distribution of the spawning stock of cod in 1960. The data are based on material collected off the south and south-west coast of Iceland. The cod were caught with longline and gill-nets during the spawning season, January to May.

There is still a dominance of the 1950 year-class, but the 1955 year-class seems to be very promising. Table 16 shows only data for the mature fish, if we, however, include the immature part of the population present on the spawning grounds it is seen that the 1955 year-class constitutes about 17% of the catch, which is a very high figure for this age-group.

The number of first-time spawners is very high, 78%, compared with the average figure of 55% for the period 1949/1958. Only 2.6% of the fish are 12 years and older compared with the average of 17% for the period 1949/1958.

Jón Jónsson

Table 16. Icelandic spawning stock of cod, 1960

Age-groups	Age at first spawning 4	5	6	7	8	9	10	11	12	13	14	Total
IV	84	—	—	—	—	—	—	—	—	—	—	84
V	42	1,011	—	—	—	—	—	—	—	—	—	1,053
VI	—	39	1,131	—	—	—	—	—	—	—	—	1,170
VII	—	6	129	1,215	—	—	—	—	—	—	—	1,350
VIII	—	3	33	189	1,134	—	—	—	—	—	—	1,359
IX	—	—	3	63	256	1,149	—	—	—	—	—	1,471
X	—	—	12	54	132	574	1,765	—	—	—	—	2,537
XI	—	—	6	18	45	63	265	319	—	—	—	716
XII	—	—	3	6	30	27	27	24	12	—	—	129
XIII	—	—	—	3	3	12	9	9	6	3	—	45
XIV	—	—	—	3	3	—	6	3	3	—	3	21
XV	—	—	—	3	9	12	15	6	3	—	3	51
XVI	—	—	—	—	3	—	—	6	—	—	—	9
XVII	—	—	—	—	—	3	—	—	—	—	—	3
Total	126	1,059	1,317	1,554	1,615	1,840	2,087	367	24	3	6	9,998

	Spawning classes 1	2	3	4	5	6	7	8	9	Total
Number	7,826	1,527	336	147	84	36	21	12	9	9,998

German Investigations, 1960

(Tables 17–18)

The yields of the cod fishery off Iceland, carried out by German trawlers, increased in 1960 to 30,595 tons, the highest since 1955 when the rich 1945 year-class gave the best results. The percentage of cod in the total catch increased to 25.8%, the highest value since 1946. Eighty per cent of these cod were caught off NW Iceland and 13.3% off SW Iceland.

As in 1959, the rich 1950 year-class was of greatest commercial value. This year-class dominated in the catches of the spring fishery off the SW coast with 41.5%, but its share decreased in the summer and autumn fishery off the NW coast from 21.0% in 1959 to 17.9% in 1960 (see Table 17). In the north-western region the younger year-classes of 1956 and 1955 are now the dominant ones with 21.7% and 20.4% respectively.

With an average daily catch of 12.6 tons the fishery for cod was by far the best in the Gammelloch area during May. As can be deduced from length and age determinations, otolith readings, average length of the year-classes, examination of maturity, and recaptures of tagged cod these good catches in May were largely the result of a strong immigration of cod coming from East Greenland. In March and April the average length of the 1950 year-class was 85.9 cm off SW Iceland, but in May it was only 81.4 cm off NW Iceland. This smaller length of the 10 year-old cod resembles more the mean length of 78.8 cm of the cod fished during the period January to April off East Greenland (Angmagssalik and Møsting area); these cod are either spawning or *en route* to Iceland where probably in most cases they are spawning off NW Iceland. Most of the cod fished there at the end of May were just spent, 11%, however, were still spawning or just going to spawn. Recent German tagging

Table 17. Length and age composition of cod taken by German trawlers SW and NW of Iceland in 1960 (‰)

Length, cm	SW Iceland March–April	NW Iceland May–August
45– 49	—	17
50– 54	2	35
55– 59	1	69
60– 64	1	109
65– 69	20	120
70– 74	76	150
75– 79	183	175
80– 84	266	166
85– 89	236	84
90– 94	137	47
95– 99	48	18
100–104	19	6
105–109	6	3
110–114	3	1
115–119	—	—
120–124	1	—
>124	1	—
Average length, cm	84.4	74.2
Year-class		
1957	—	35
1956	—	217
1955	20	204
1954	30	89
1953	119	95
1952	129	66
1951	135	53
1950	415	179
1949	118	56
before 1949	34	6

Table 18. Recaptures from German tagging experiments off SW, S, and SE Greenland

	Date and location of tagging	recapture	
1959			
19. Dec.	Dana Bank 62°37′N, 51°28′W	end of April to beginning of May 1960	NW Iceland, Gammelloch
26. Oct.	Nanortalik Bank 60°08′N, 46°20′W	end of May 1960	Iceland, Cape North
18. Dec.	off Sermersut 61°19′N, 49°49′W	1. June 1960	Gammelloch
13. Dec.	Bille Bank 62°02′N, 40°38′W	end of July 1960	Gammelloch

experiments off SW, S, and E Greenland and 4 recaptures off NW Iceland again prove the immigration of cod from Greenland into NW Icelandic waters (see Table 18).

ARNO MEYER

Arcto-Norwegian Stock

German Investigations, 1960

(Figure 12; Table 19)

According to the results of the German fishery operated off the Norwegian coast, the stock of skrei has reached its poorest state since 1934, when

Table 19. Length and age composition of Arcto-Norwegian cod in 1960

	Commercial trawler	"Anton Dohrn"					
	Norwegian coast	Barents Sea				Bear Island	
	Malangen/Røst	Finnmark	Skolpen Bank		Tiddly Bank	SE	SW
	Jan./Mar.	Nov.	Nov.		Nov.	Nov.	
Length, cm	110 mm ‰	110 mm ‰	110 mm ‰	12 mm ‰	12 mm ‰	110 mm ‰	12 mm ‰
5– 9	—	—	—	5	16	—	3
10– 14	—	4	—	40	85	—	28
15– 19	—	4	—	23	28	12	34
20– 24	—	28	25	20	58	31	63
25– 29	—	22	101	106	74	27	93
30– 34	—	30	232	194	112	67	114
35– 39	—	54	177	172	125	188	197
40– 44	—	49	82	95	135	219	159
45– 49	2	116	78	76	113	169	117
50– 54	12	241	50	44	101	118	78
55– 59	26	172	32	38	53	94	46
60– 64	68	140	27	29	45	27	30
65– 69	69	65	36	37	17	20	21
70– 74	60	28	48	27	14	12	10
75– 79	61	26	40	36	4	4	3
80– 84	83	13	30	25	4	4	3
85– 89	103	2	19	19	—	8	—
90– 94	145	—	10	6	8	—	1
95– 99	133	—	9	5	1	—	—
100–104	106	4	4	—	3	—	—
105–109	66	—	—	3	3	—	—
110–114	39	—	—	—	1	—	—
115–119	14	—	—	—	—	—	—
120–124	9	—	—	—	—	—	—
125–129	4	2	—	—	—	—	—
Average length	88.1	53.6	46.2	43.4	40.0	45.1	39.7
Year-class							
1960	—	—	—	44	75	—	27
1959	—	36	8	30	57	29	75
1958	—	36	219	185	159	100	200
1957	5	134	391	394	308	367	349
1956	19	475	126	136	242	335	230
1955	55	137	29	25	51	89	58
1954	144	161	135	111	79	68	57
1953	57	11	40	33	11	—	—
1952	50	—	21	20	3	8	3
1951	144	4	4	4	—	—	—
1950	339	3	27	18	15	4	1
1949	49	3	—	—	—	—	—
1948	75	—	—	—	—	—	—
before 1948	63	—	—	—	—	—	—

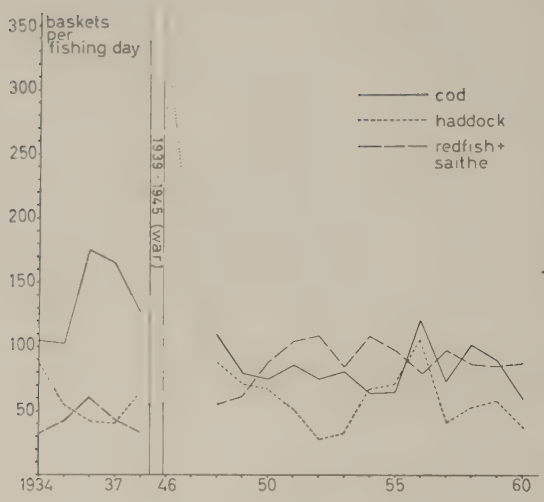

Figure 12.

German trawlers started this fishery off the Lofotens. The average catch per day during the main cod fishing season (January to April) dropped from 6.06 tons in 1956 to 2.95 tons in 1960 (see Fig. 12) although there was no increased fishing for redfish or saithe (Fig. 12).

Further evidence of the poor state of the spawning stock is the increasing average length which has risen gradually since 1956 (when the last rich year-class (1950) entered the skrei fishery) from 75.6 cm to 88.1 cm in 1960. The age determinations reveal also the poor recruitment to the spawning stock. Since 1957 the 1950 year-class has been predominant and these 10 year-old cod have now reached an average length of 95.7 cm. The contribution of the 1951 year-class was nearly the same as in 1959 and the 1954 year-class, the first richer year-class since 1950, is of equal strength.

Owing to the poor state of the stock of cod there were only small-scale operations by the German trawlers in the Barents Sea (mostly off the Finnmark coast) and no fishing in the Bear Island region. A research trip of "Anton Dohrn" at the end of November gave very poor results; a maximum of 14 baskets per hour was taken off Finnmark, 11 baskets on the Skolpen Bank, and only 7 baskets on the Tiddly Bank and SE of Bear Island. Fishing with a mesh size of 110 mm showed that on the Skolpen Bank and in the Bear Island region the cod were very small (only 30% of the commercial size, i.e. 50 cm and over). Only in the Finnmark area 70% of the fish were of commercial size. The age determinations revealed that the 1957 year-class was predominant when fishing with 110 or 12 mm mesh size, followed by the 1956 and 1958 year-classes (Table 19). The samples showed furthermore that the last good year-class (1954), which has suffered the high fishing effort during the most recent years, is now very weak.

ARNO MEYER

Baltic Stock

Polish Investigations in the Southern Baltic, 1960

(Table 20)

The cod started spawning in March and the first maximum occurred in April. The second one was observed in July; this phenomenon was rather abnormal. The ecological conditions of the spawning were rather poor, i.e. low salinity in the deeps, poor light conditions, and low quantities of feeding organisms.

The pre-spawning and spawning concentrations of the cod shoals were quite dense in February/April and the results of exploitation during the main season were good. The total catch of cod in 1960 was higher than in the previous two years and amounted to over 48,000 tons.

The age composition of the Polish cod catches in relation to weight is given in Table 20.

The proportion of juvenile cod (1959 and 1958 year-classes) in the catches was rather low. The 1957 year-class was abundantly represented thus confirming the previous forecasts that the brood of 1957 was very strong. There was a decline in the representation of the important 1954, 55, and 56 year-classes.

It is generally concluded that a further improvement of the stock of cod in 1961/62 cannot be expected.

ST. RUTKOWICZ

Table 20. Age composition of the Polish catches of cod in relation to weight (%)

Age-group	I	II	III	IV	V	VI	VII	VIII	IX
Year-class	1959	1958	1957	1956	1955	1954	1953	1952	1951
Weight proportion	0.3	11.1	38.0	21.6	20.0	6.5	1.4	0.8	0.3

Table 21. Age composition of cod and mean catch per hr trawling (kg) in the Gothland and Gdansk Deeps during the spawning seasons, 1956/1960

Years	Age-groups							Mean catch per hr		
	II	III	IV	V	VI	VII	VIII	First half	Second half	Yearly average
1956	5.3	34.0	30.0	17.2	9.5	2.4	1.6	130.0	107.5	116.0
1957	3.7	38.0	42.3	12.0	3.0	1.0	—	146.0	84.3	115.0
1958	0.3	27.5	46.1	20.5	3.3	2.2	0.1	116.2	59.2	88.0
1959	4.6	15.0	37.9	34.1	6.8	1.3	0.3	90.8	74.0	82.5
1960	6.0	48.2	30.0	11.5	3.3	0.9	0.1	98.0	50.0	79.0

Table 22. Mean length (cm) of Baltic cod in the period 1956 to 1960

Years	Age-groups				
	II	III	IV	V	VI
1956	27.0	34.5	40.5	49.5	65.0
1957	27.5	37.0	42.3	52.9	62.5
1958	—	37.3	42.6	49.5	59.0
1959	28.5	35.5	43.5	51.0	62.0
1960	—	36.7	44.5	53.2	59.5

Soviet Investigations in the Southern Baltic, 1960

(Figure 13; Tables 21–22)

The fishable stock of cod in 1960 was represented mainly by 3 and 4 year-old fish of the rich 1957 year-class and the poor one of 1956.

During the period 1956/59 the abundant 1953 and 1954 year-classes have been exploited by the fisheries, i.e. at an age of up to five years. In 1960 they occurred in the catches only in small numbers. Age composition and mean length are given in Tables 21 and 22.

As seen from Table 21, 2 year-old cod of the 1958 year-class formed a substantial proportion of the catches in the spring of 1960. Later on, however, in the autumn and winter of 1960/61 there was a great decline in the numbers of this year-class; it cannot therefore be regarded as abundant.

During the first half of the year, the catches increased somewhat, due to the entry of the rich 1957 year-class; they decreased, however, during the second half of the year as a result of the poor strength of the older age-groups of cod and the relatively low numbers of the 1957 year-class.

The character of recruitment can be judged from the catches of feeding cod. Figure 13 shows the length composition of these fish caught in the winter of 1960/61. Figure 13 has two peaks, one (40 to 45 cm) corresponding to the 1957 year-class, which prevailed in the catches, and another referring to the 1959 year-class (2 year-olds). The 1958 year-class was very poorly represented.

It is anticipated that the 1959 year-class will be the sole fishing resource in the period 1962 to 1969, since the 1958 year-class is not very abundant and the numerous 1957 year-class will then to a considerable degree have been exploited by the fisheries

The abundance of the 1959 year-class was stipulated by the favourable hydrological conditions in the Baltic Sea in the spring of 1959. The occurrence in the autumn of 1958 of an inflow of highly saline, near-bottom waters resulted in an increase in

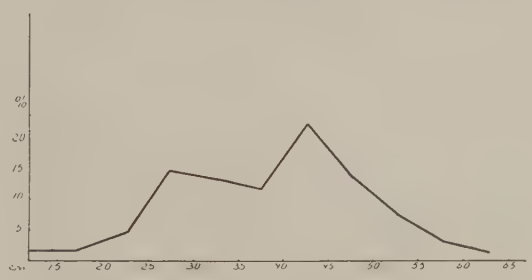

Figure 13. Length distribution of cod in the winter 1960/61 in the areas of Klaipeda and Gdansk Bay.

salinity on the spawning grounds of Bornholm Deep (March 1959) of 1.1 to 1.5‰, and in the Gdansk Deep of 0.5‰, compared with 1958. At the same time the oxygen content in Bornholm Deep rose from 0.2 to 1.4 ml/l and in the Gdansk Deep from 1.0 to 2.3 ml/l.

A further increase in salinity occurred in May accompanied by an increase in oxygen content of up to 3.8—4.8 ml/l in the deep-water guts of the southern Baltic.

All these factors have favourably influenced the initiation of the 1959 year-class and increased its abundance.

N. P. Biryukov, G. I. Tokareva

Distribution and Age Composition of Cod in the Gothland Deep in 1960

(Tables 23–24)

The spawning conditions in the Gothland Deep in spring 1960 were better than in 1958/59; both salinity and oxygen content showed considerable increases; the 18% isoxygene went down to 115 m and the 11‰ isohaline rose to 90 m.

Correspondingly, migrations of cod from the Gothland Deep area to the south-western Baltic for spawning were less intensive than in 1958/59. This is confirmed by both the results of tagging experiments and the analysis of maturity stages of the cod in the Gothland Deep.

Both pre-spawning and spawning concentrations of cod in the Gothland Deep were stable and large in 1960; for the most part the fish kept to the 100—130 m layer, that is, deeper than in 1959.

In spring 1960 the cod fisheries in Gothland Deep were successful; the trawlers of the Latvian SSR caught in March/May 1960 almost twice as many cod as in the corresponding period of 1959. The catches increased owing to the entry of the moderately abundant 1957 year-class and the improved hydrological conditions in the Deep.

The catches of cod taken in the Gothland Deep in 1960 were mainly composed of 3 to 5 year-old fish (Table 24).

I. A. Lablaika

Table 23. Distribution of cod in the central Baltic in 1959/60 by stages of maturity

Month	Year	Maturity stages (%) I–II	III	IV	V–VI
April	1959 ..	35	42	23	—
	1960 ..	13	7	16	64
June	1959 ..	85	12	3	—
	1960 ..	81	2	7	10

Table 24. Age composition of spawning cod in the Gothland Deep (%)

Year	Age-groups I–II	III	IV	V	VI	VII	VIII	Total
1959	4.6	7.2	20.0	40.0	14.0	3.6	1.6	100.0
1960	3.6	39.1	34.2	17.8	4.6	0.6	0.1	100.0
1953–60 .	3.4	28.7	42.1	18.5	6.9	1.9	0.4	

HADDOCK

Greenland Stock

German Investigations, 1960

(Table 25)

Up to the present, haddock have only been caught as single specimens off West and South Greenland; they were always large fish of 50 to 75 cm length. During a trip for cod tagging, several small haddock (up to 25 fish in one haul) were caught off Sermersut (61°20′N, 50°W) and on the Dana Bank (62°30′N, 50°30′W) in September/October 1960. The catch consisted of one to three year-old haddock, but mostly 2 year-olds (Table 25) with an average length of 25.4 cm (I-group), 34.6 cm (II-group), and 43.0 cm (III-group). This means that these West Greenland haddock had grown more rapidly than, for example, the haddock of the Barents Sea; at the end of November 1960 the average lengths of the latter were 24.6 cm, 30.4 cm, and 40.2 cm for the age-groups in question. It must be stressed that on the otoliths of the West Greenland haddock the hyaline zones were by far not so clear as on those from Icelandic or north-eastern haddock or as might have been expected from the experience with the extraordinary good otoliths of the West Greenland cod.

Arno Meyer

Table 25. Length and age composition of haddock taken off West Greenland in 1960 (‰)

Length, cm	‰	Year-classes	‰
20–24	77	1959	207
25–29	115	1958	557
30–34	321	1957	165
35–39	282	1956	32
40–44	51	before 1956	39
45–49	51		
50–54	64		
55–59	—		
60–64	26		
65–69	—		
70–74	13		

Icelandic Stock

German Investigations, 1960

(Table 26)

The catches of haddock taken by German trawlers increased and nearly doubled in 1960, as was also the case with the cod. Most of the haddock were caught during the spring fishery off the SW coast of Iceland. The average length of the haddock, which had been oscillating between 57.8 and 61.2 cm

Table 26. Length and age composition of haddock taken by German trawlers SW of Iceland in March and April 1960

Length, cm	‰	Year-class	‰
35–39	5	1956	534
40–44	57	1955	321
45–49	286	1954	54
50–54	254	1953	27
55–59	194	1952	19
60–64	120	1951	35
65–69	44	1950	7
70–74	28	1949	1
75–79	12	before 1949	2

during the last five years, dropped to 54.1 cm due to a remarkable rejuvenation of the stock and the first appearance of the 1956 year-class, which probably is strong. These 4 year-old haddock having an average length of 49.1 cm provided 53% of the total landings from the SW coast. Next in strength was the 1955 year-class with 32% and a mean length of 56.7 cm. All the haddock of the four preceding year-classes 1954 to 1951, which together made up 62% in 1957, 80% in 1958, and 73% in 1959, are now very weak and have lost their commercial importance.

ARNO MEYER

Arcto-Norwegian Stock

Soviet Investigations on Small Haddock in the Barents Sea

(Tables 27–29)

Southern part of the Barents Sea

As in previous years, a quantitative analysis of small haddock was carried out in the Barents Sea by the scientific staff of the Polar Institute during the winter of 1959/60. The results of this estimation for the southern part of the Barents Sea are shown in Table 27.

The number of small haddock taken during the autumn/winter of 1959/60 was considerably lower than in previous years. The mean catch of young haddock of all age-groups per hour's trawling was 33 fish while in previous years it varied between 41 and 116 specimens. The 1957 year-class was predominant providing 42.4% of the total catch of young haddock in the southern Barents Sea (see Table 27). This year-class was most abundant in the coastal waters; it was especially numerous in the Motovsky Bay, providing 54.4% of the total catch.

The 1957 year-class was considered a good one as 0-group but according to the quantitative analysis carried out when it was two and three years old it can now only be considered of moderate strength (see Table 28), constituting about half of the rich 1956 year-class. The 1958 year-class is rather poor which is proved by a low abundance of young fish all over the Barents Sea. The 1959 year-class was previously estimated somewhat below average judging by the mean figures of the 0-group, but it is more abundant than the 1958 year-class. The distribution of 0-group haddock (1959 year-class) does not display any serious differences in comparison with the long-term mean. As usual, the members of this group were dispersed in the inshore, western, and central regions of the sea.

North-western areas

Generally, young haddock are sparse in the north-western areas of the Barents Sea. However, on the western slopes of the Bear Island Bank a relatively large number of small haddock (19 fish per hour's haul) was encountered. In other regions the average catch per hour did not exceed one fish (see Table 29). Young haddock were not present in the Hopen, Persey Elevation, and Western Deep areas.

Haddock of the 1959 and 1957 year-classes dominated in the catches, providing 52.8% and 29.2% respectively. The mean catch of 0-group fish (11 specimens per hour) on the western slope of the Bear Island Bank may testify to the presence in

Table 27. Mean number of young haddock of different ages caught per hour's trawling in the southern part of the Barents Sea

Areas	Month of sampling	Number of hauls	Age and year-class 0+(1) 1959	1+(2) 1958	2+(3) 1957	3+(4) 1956	Total	Total number of fish
Central	Oct.–Feb.	168	4	<1	8	4	17	2,952
Western	Oct.–Feb.	246	8	5	12	8	33	8,080
Coastal	Oct.–Feb.	68	11	9	37	15	72	4,944
Total		482	7	4	14	8	33	15,976
% of total			22.0	11.7	42.4	23.9		
Motovsky Bay	Oct.–Dec.	46	19	18	59	12	108	4,947
% of total			18.1	17.2	54.4	10.3		
Eastern	Nov.	45	<1	—	3	1	4	194
North-eastern	Nov.	27	—	—	—	—	—	—
Central Elevation	Oct.–Feb.	29	<1	<1	—	—	<1	21

Table 28. Mean number of 1–4 year-old haddock of the different year-classes caught per hour's trawling in the western, central, and coastal areas of the Barents Sea during the autumn/winter of 1959/60

Year-class	1 year-old	2 year-old	3 year-old	4 year-old	Long-term mean of 2 and 3 year-olds
1946	1	—	1	3	1
1947	—	1	1	1	1
1948	5	32	26	13	30
1949	3	1	11	2	7
1950	80	247	262	87	256
1951	22	19	12	12	15
1952	8	5	10	4	7
1953	11	40	25	10	31
1954	10	7	3	3	5
1955	8	3	2	3	3
1956	26	18	27	8	23
1957	38	9	14	—	12
1958	2	4	—	—	—
1959	7	—	—	—	—
Long-term mean, 1950 excluded, (approx.)	11	11	12	6	12

Table 29. Mean number of young haddock of different ages caught per hour's trawling in the north-western areas of the Barents Sea

Areas	Month of sampling	Number of hauls	Age and year-classes 0+(1) 1959	1+(2) 1958	2+(3) 1957	3+(4)[1] 1956	Total	Total number of fish
Bear Island area:								
Southern Slope	Nov.–Dec.	34	<1	<1	—	—	<1	18
Eastern Slope	Oct.–Dec.	21	<1	—	—	—	<1	7
Western Slope	Sept.–Jan.	49	11	2	5	1	19	942
Total		104	5	1	2	1	9	967
% of total			59.4	11.5	27.9	1.2		
West Spitsbergen	Sept.–Dec.	59	<1	1	1	<1	3	212
South Cape Gully	Sept.–Jan.	40	1	<1	<1	<1	1	48
Hopen area	Oct.–Nov.	27	—	—	—	—	—	—
Persey Elevation	Oct.	17	—	—	—	—	—	—
Western Gully	Oct.	11	—	—	—	—	—	—
Total number for all areas		248	2	<1	1	<1	4	1,227
% of total			52.8	16.2	29.2	1.8		

[1]) This group includes only specimens below 36 cm in length.

1959 of a large drift of haddock larvae and fry along the Spitsbergen Current. During the cruise of the R. V. "Tunetz", single specimens of 0-group haddock were encountered on 20. September 1959 north of 79°N, off West Spitsbergen.

A. S. Baranenkova

Adult Haddock in the Barents Sea, 1960

(Figures 14–16)

Length and age composition of haddock in the Barents Sea and near the north-western Norwegian coast was investigated in 1960 by the scientific staff of the Polar Research Institute from the R. V. "Persey II", "Tunetz", and the scouting trawlers "Melitopol", "Rostov", and others.

Figure 14 shows length, age, and weight composition of haddock of the southern part of the Barents Sea, and from some western, coastal, south-eastern, and central areas. All over these regions the 3—4 year-old haddock, 35-50 cm long, belonging to the 1956 and 1957 year-classes prevailed.

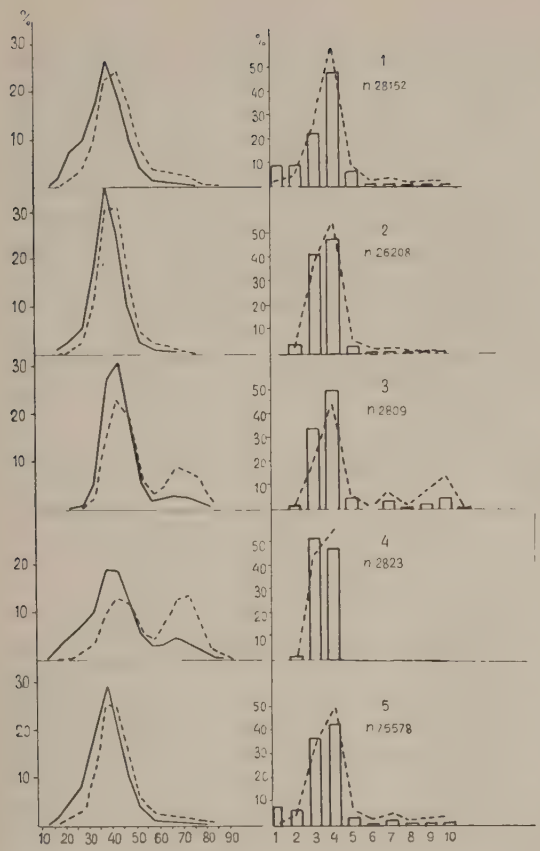

Figure 14. Length (solid line), age (columns), and weight (stippled line) of the haddock in the western (1), coastal (2), south-eastern (3), central (4), and in the whole of the southern area of the Barents Sea (5) in 1960.

The following main concentrations were observed in the southern part of the Barents Sea: January/March, on the Murman Bank; May/September, in the coastal areas; August, on the Kanin Bank; October, in the Murman shallow water area; and in November/December, on the Murman Bank. Owing to the strong cooling of the near-bottom waters of the SE Barents Sea, the Kanin Bank haddock remained in separate concentrations in the warmest sections and chiefly in mid-water layers. In 1960 haddock migrations to the regions situated to the east of the Kanin Peninsula were not observed.

In the samples collected in 1959/60 in the north-western area of the Norwegian coast from Røst Bank to Fugløy Bank the haddock of the 1950, 1953, 1954, and 1955 year-classes, 50—70 cm long, were predominant (see Fig. 15). The ratio of the specimens belonging to the different year-classes was different. In 1959 the 1950 year-class constituted 36% of the mature part of the stock, and in 1960 they formed only 13%. In 1960 the number of fish belonging to the 1953 and 1955 year-classes increased on the spawning grounds.

In the north-western areas of the Barents Sea haddock were scarce. In the samples collected in May 1960 (204 fish) in the West Spitsbergen area and in November (91 fish) on the western slope of the Bear Island Bank the 26—45 cm haddock belonging to the 1957 year-class (77%, 55%), the 1956 year-class (18%, 30%), and the 1958 year-class (14%, 9%) were predominant.

Figure 16 shows the number of fish of different lengths taken per hour's trawling in the southern part of the Barents Sea over a period of 15 years. The data are expressed in absolute values (left) and in form of deviations from the long-term average range (right). From the figure it is clearly seen that negative deviations are predominant from 1946 to 1951. During the period 1952 to 1957 the stock of haddock increased considerably in the southern part of the Barents Sea. In 1952 the haddock of 15—35 cm length were plentiful, while other length groups were scarcely represented. In the following years the peak of the curve moved gradually to the right and in 1956 only large fish of equal size (45—65 cm) were numerous. The age determination data show that these haddock belonged to the 1950 year-class. In 1957 the small haddock (30—45 cm) of the 1953 year-class were again frequent. The number of fish

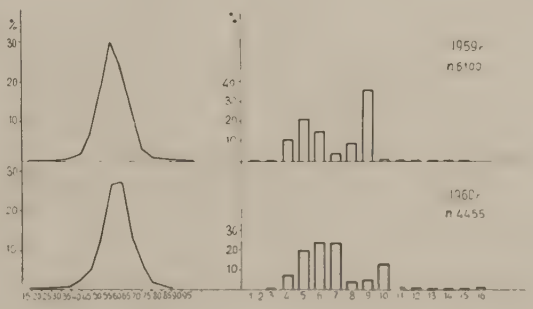

Figure 15. Length (left) and age (right) of the haddock in the vicinity of the NW coast of Norway.

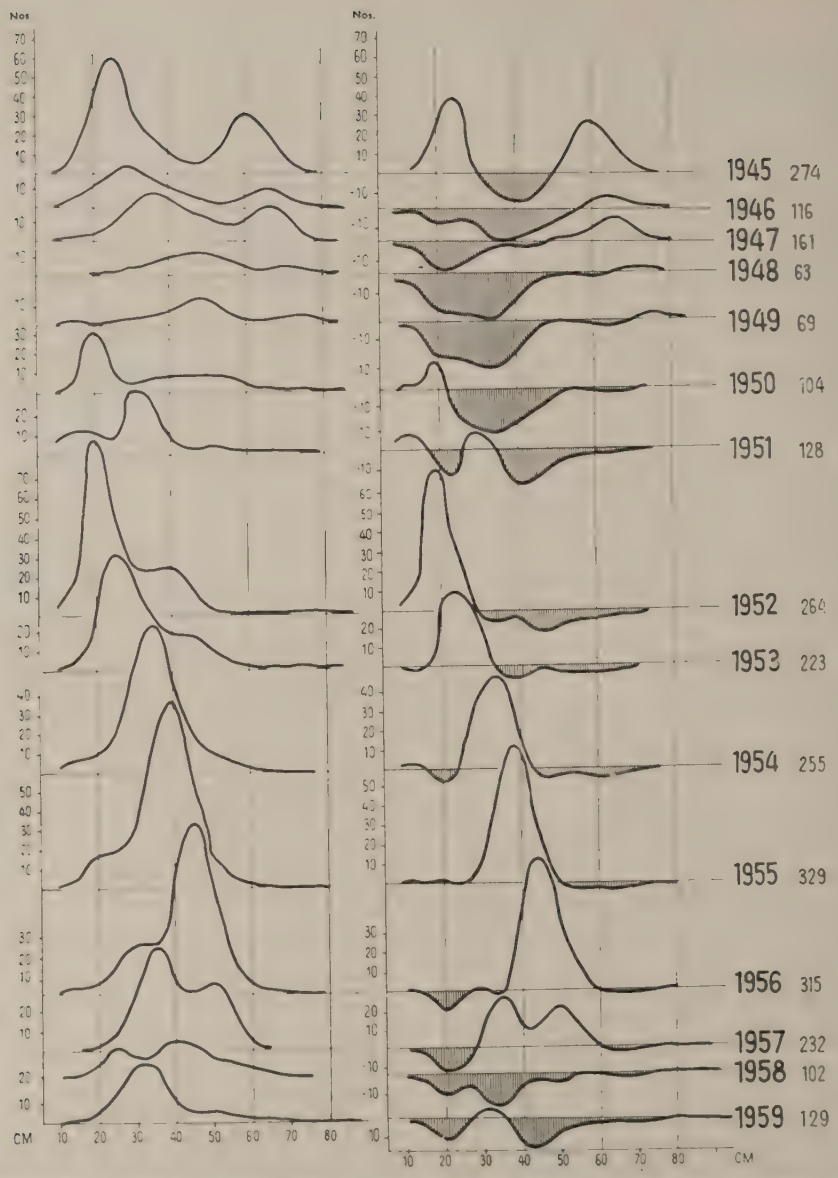

Figure 16. Number of haddock of different sizes caught per hour's trawling in the period 1945–1959 presented in absolute values (left) and as deviations from the long-term average range (right).

belonging to the 1950 year-class considerably decreased. In 1958 and 1959, the haddock stocks in the southern Barents Sea were found to be at a low level. In 1960 the stock increased slightly. In 1960 the mean catch per hour's trawling was 130 kg, whereas in 1959 and 1958 it was 90 kg.

M. A. Sonina

German Investigations, 1960

(Table 30)

As anticipated in 1959, the haddock catches showed a further decline off the Norwegian coast. The average daily yield during the 1960 season (Jan./Apr.) dropped to 1.83 tons, which is the third lowest catch since 1934 when German trawlers started fishing off the Norwegian coast (see Fig. 12, this section). A further sign of the diminishing stock is the high average length of 63.2 cm. Whilst the extraordinary strong 1950 year-class has been predominant for the last four years, providing between 40% and 65% of the total catch, it is now down to 26%. But this year-class was still of great commercial importance due to the high average length of 69.1 cm. The 1953 year-class with an average length of 61.8 cm was the most numerous (Table 30).

A research trip with the "Anton Dohrn" at the end of November gave only small catches: a maximum of 11 baskets per hour off the Finnmark coast (average 5 baskets), 10 baskets on the Skolpen Bank (average 6.5 baskets), and 3.5 baskets on the Tiddly Bank (average 2.5 baskets). From the length and age composition it is seen that the catches, even those with 110 mm mesh size, consisted largely of rather small fish, and that haddock older than 4 years of age were very scarce.

ARNO MEYER

Table 30. Length and age composition of Arcto-Norwegian haddock in 1960

	Norwegian Coast Market samples		Barents Sea "Anton Dohrn" samples		
	Malangen/ Røst	Finn-mark	Skolpen Bank		Tiddly Bank
	Jan./Mar.	Nov.	Nov.		Nov.
Length, cm	110 mm ‰	110 mm ‰	110 mm ‰	12 mm ‰	12 mm ‰
5– 9 ...	—	—	—	—	—
10–14 ..	—	8	3	16	138
15–19 ...	—	20	13	55	124
20–24 ...	—	69	84	154	208
25–29 ...	—	113	139	210	154
30–34 ...	—	74	139	154	51
35–39 ...	—	72	118	78	65
40–44 ...	6	86	209	132	112
45–49 ...	22	208	165	99	104
50–54 ...	67	204	79	65	25
55–59 ...	213	94	21	11	8
60–64 ...	324	38	7	7	8
65–69 ...	219	3	14	7	3
70–74 ...	104	8	6	6	—
75–79 ...	35	2	2	5	—
80–84 ...	8	1	1	1	—
85–89 ...	2	—	—	—	—
Aver. length	63.2	43.3	39.3	34.5	29.1
Year-class					
1960	—	26	14	70	253
1959	—	166	200	325	340
1958	—	81	141	172	73
1957	—	319	273	177	140
1956	13	324	330	220	166
1955	98	61	11	9	22
1954	181	16	7	4	3
1953	326	7	1	3	3
1952	71	—	4	2	—
1951	26	—	—	—	—
1950	257	—	16	12	—
1949	4	—	—	—	—
1948	24	—	3	6	—

Faroe Stock

Scottish Investigations, 1960

(Tables 31–32)

Market sampling of the Faroe haddock stock has been continued as in previous years. The data are given in Table 31 (ee next page).

Age composition

The age composition of the haddock sampled from commercial trawlers is shown in Table 31 A. The mean lengths of each year-class are given in Table 31 B and in Table 31 C are shown the estimated weights of each year-class landed per ten hour's fishing each month. These were determined by converting the mean lengths in Table 31 B to weights (using data from RUSSELL, 1914[1]) and then by multiplying each by the appropriate number per 10 hours' fishing from Table 31 A. As in previous years the younger age-groups (II to VI) made up the greater part of the landings. There was also the usual tendency for the mean lengths to decrease during the spring, this year the decrease being from March to April.

Commercial landings

The average weights of haddock landed per 100 hours' fishing by Aberdeen trawlers from Faroe during 1960 are shown in Table 32. The mean catch per 100 hours of 117 cwt represents a sharp decline from the mean value of 163 cwt for 1959 and continues the decline that began in 1958.

R. JONES

[1]) RUSSELL, E. S. (1914) Fish. Invest., Lond., Ser. 2 1(1).

Table 31. Aberdeen trawlers, market samples – Faroe haddock 1960

A. Number landed per 10 hours' fishing

Brood	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1959	—	—	—	—	—	—	1	35	165	154	107	88
1958	107	31	36	75	172	694	433	442	424	384	386	468
1957	729	350	361	600	386	579	382	254	256	194	159	200
1956	309	175	234	477	188	176	152	90	110	37	67	99
1955	98	69	43	223	52	49	56	47	36	13	28	56
1954	26	37	20	73	23	37	19	25	26	8	19	21
1953	34	28	19	41	18	30	27	18	21	5	9	10
1952 and older	11	11	5	8	7	12	7	4	4	2	3	2
Total	1,314	701	718	1,497	846	1,577	1,077	915	1,042	797	778	944

B. Mean lengths of each age-group sampled

1959	—	—	—	—	—	—	29.0	28.3	30.3	30.8	31.5	31.5
1958	31.7	31.4	33.3	31.6	33.2	32.8	34.2	34.2	34.8	37.0	36.4	36.7
1957	37.3	36.8	38.6	37.5	37.5	38.4	41.7	40.7	41.3	44.8	43.8	45.0
1956	44.2	46.1	44.7	44.9	44.0	45.3	48.8	47.0	47.8	50.5	50.0	51.0
1955	50.2	50.5	51.4	45.4	51.3	50.7	53.5	52.2	52.9	55.2	54.4	55.7
1954	55.4	55.2	55.9	51.1	55.3	55.4	57.1	57.5	57.6	58.8	57.8	57.8
1953	58.9	59.4	60.2	55.4	60.2	59.5	61.9	60.5	59.7	64.1	60.7	61.6
1952	66.8	63.8	66.8	63.9	65.1	64.8	68.2	64.8	63.9	67.2	66.8	70.1

C. Estimated[1]) weights landed per 10 hours' fishing (cwt)

1959	—	—	—	—	—	—	0	0.13	0.74	0.75	0.56	0.44
1958	0.54	0.15	0.20	0.36	0.89	3.89	2.85	2.93	2.97	3.27	3.10	3.80
1957	6.23	2.70	3.17	5.00	3.28	5.39	4.66	2.90	3.04	3.02	2.32	3.12
1956	4.30	2.79	3.15	6.66	2.58	2.74	2.96	1.59	2.05	0.83	1.46	2.29
1955	2.15	1.49	0.90	3.24	1.11	1.06	1.46	1.16	0.93	0.38	0.80	1.71
1954	0.78	1.02	0.50	1.54	0.62	1.06	0.61	0.83	0.86	0.29	0.65	0.72
1953	1.24	0.97	0.63	1.08	0.65	1.07	1.10	0.70	0.78	0.23	0.36	0.40
1952 and older	0.60	0.45	0.22	0.35	0.31	0.58	0.38	0.19	0.18	0.10	0.17	0.12
Totals	15.84	9.57	8.77	18.23	9.44	15.79	14.02	10.43	11.55	8.87	9.42	12.60

[1]) Using data from RUSSELL, 1914.

Table 32. Landings of three size categories of haddock by Aberdeen trawlers from Faroe 1960

Months	Hours fishing	Cwt per 100 hours Large	Medium	Small	Total
January	6,582	30.9	50.2	76.1	157.3
February	8,197	25.2	26.2	45.1	96.5
March	9,277	21.5	27.1	42.7	91.3
April	7,982	43.4	47.1	90.7	181.2
May	6,070	18.3	23.4	46.0	87.7
June	15,956	36.0	25.2	91.2	152.4
July	14,367	25.5	29.2	78.1	132.7
August	13,395	23.8	23.7	55.0	102.5
September	13,330	25.1	26.1	60.9	112.1
October	12,525	15.5	16.9	49.2	81.7
November	9,132	14.3	18.9	58.0	91.2
December	9,681	17.2	23.9	76.8	118.0
Total/Mean	126,494	24.9	27.0	65.5	117.4

North Sea Stock

Scottish Investigations, 1960

(Tables 33-36)

Age composition

During 1960 F. R. S. "Scotia" completed three routine surveys of the North Sea in March, June, and September. The age compositions of the haddock captured per 10 hours' trawling are shown in Table 33. As in 1959, the very good 1955 and fairly good 1958 year-classes still persist in the catches. Catches of the 1959 year-class compared with catches of the 1958 year-class last year suggest that this year-class may be rather better than was at first thought and can be classed as an almost good year-class. It is interesting that whereas during 1959 and 1960 the 1958 year-class has predominated in the northern area, the distribution of the 1959 year-class is rather different in so far as it is most abundant in the central area.

0-group haddock (1960 year-class) were caught during the September cruise in moderate numbers in most areas except the central area.

Size composition

The mean lengths of haddock sampled in 1960 are given in Table 34.

Table 33. Age composition of haddock caught by F. R. S. "Scotia" in 1960 per 10 hours' trawling

Area	*Northern Area*				*North Central Area*			
Cruise	Feb./Apr.	June	Sept.	All Cruises	Feb./Apr.	June	Sept.	All Cruises
No. of hauls	7	5	10	22	21	7	19	47
Year-class				Weighted means				Weighted means
1960	—	—	143	143	—	—	124	124
1959	531	34	191	264	665	78	82	342
1958	1368	486	1202	1092	943	180	258	552
1957	48	22	81	57	18	0	7	11
1956	38	10	23	25	1	1	2	1
1955	201	58	108	126	36	17	13	24
1954 and older	36	4	16	20	4	0	0	2

Area	*Central Area*			*Moray Firth & Orkney*				*Firth of Forth*
Cruise	Feb./Apr.	June	All Cruises	Feb./Apr.	June	Sept.	All Cruises	Feb./Apr.
No. of hauls	7	7	14	7	1	4	12	3
Year-class			Weighted means				Weighted means	
1960	—	—	—	—	—	398	398	—
1959	1221	344	782	14	0	3	9	3
1958	724	148	436	53	1470	117	192	0
1957	33	10	22	4	40	12	10	0
1956	8	1	4	0	0	5	2	0
1955	66	8	37	4	60	12	11	0
1954 and older	6	1	4	1	10	2	2	0

Note: Central Area not visited in September. Firth of Forth Area not visited in June and September.

Table 34. Mean length (cm) and range of means of haddock of each age-group from the North Sea in 1960

Area			*Northern*			*North Central*			*Central*		
Year-class	Age	Cruise	Mean	Range of means	No. of fish	Mean	Range of means	No. of fish	Mean	Range of means	No. of fish
1960	0+	Sept.	11.3	10.0–13.3	143	12.8	12.0–14.4	235	—	—	—
1959	0+	Feb./Apr.	18.7	17.0–21.3	372	18.0	14.0–21.0	1396	19.4	17.9–21.2	855
	1+	June	23.7	23.3–24.0	17	21.6	17.0–24.1	55	23.0	20.6–25.0	241
	1+	Sept.	25.8	25.0–26.6	191	26.3	24.1–28.6	155	—	—	—
1958	1+	Feb./Apr.	27.8	26.9–29.5	958	27.3	25.7–30.0	1980	30.4	28.7–33.3	507
	2+	June	29.0	27.6–29.8	243	29.4	27.6–33.5	126	32.2	30.0–37.0	104
	2+	Sept.	30.2	28.6–32.2	1202	31.4	28.9–35.1	491	—	—	—
1957	2+	Feb./Apr.	35.3	32.0–37.0	34	37.5	34.7–45.0	38	36.6	35.0–37.7	23
	3+	June	32.3	30.7–34.3	11	—	—	—	43.2	39.4–47.0	7
	3+	Sept.	36.5	34.0–38.6	81	36.6	34.0–40.5	13	—	—	—
1956	3+	Feb./Apr.	34.7	33.5–37.7	27	36.9	35.0–40.0	2	38.9	37.3–42.0	6
	4+	June	38.3	36.0–40.0	5	37.0	37.0	1	38.0	38.0	1
	4+	Sept.	37.0	35.0–40.3	23	38.3	36.0–41.0	3	—	—	—
1955	4+	Feb./Apr.	37.9	36.0–39.9	141	41.5	35.0–54.0	76	42.2	40.0–44.3	46
	5+	June	39.2	38.7–40.0	29	41.6	37.3–46.0	12	40.1	39.0–41.2	6
	5+	Sept.	40.8	39.2–42.2	108	41.4	38.0–47.5	24	—	—	—

Area			*Moray Firth & Orkney*			*Firth of Forth*		
Year-class	Age	Cruise	Mean	Range of means	No. of fish	Mean	Range of means	No. of fish
1960	0+	Sept.	13.2	11.8–15.1	159	—	—	—
1959	0+	Feb./Apr.	18.4	15.5–21.0	10	20.0	20.0	1
	1+	June	—	—	—	—	—	—
	1+	Sept.	20.0	20.0	1	—	—	—
1958	1+	Feb./Apr.	30.2	29.8–31.2	37	—	—	—
	2+	June	27.1	27.1	147	—	—	—
	2+	Sept.	31.0	29.0–32.9	47	—	—	—
1957	2+	Feb./Apr.	38.5	38.0–39.0	3	—	—	—
	3+	June	34.2	34.2	4	—		—
	3+	Sept.	36.2	36.2	5	—	—	—
1956	3+	Feb./Apr.	—	—	—	—	—	—
	4+	June	—	—	—	—	—	—
	4+	Sept.	38.0	38.0	2	—	—	—
1955	4+	Feb./Apr.	47.8	46.0–49.5	3	—	—	—
	5+	June	39.2	39.2	6	—	—	—
	5+	Sept.	41.8	41.8	5	—	—	—

Table 35. Landings of haddock by British steam trawlers from the North Sea in 1959

Quarterly period	North of Lat. 57°30′N			Lat. 55°N to 57°30′N		
	Weight landed/ 100 cwt	100 hrs fishing	Weight landed/ 100 hrs	Weight landed/ 100 cwt	100 hrs fishing	Weight landed/ 100 hrs
Jan.–March	994	550	181	179	238	75
April–June	957	458	209	158	360	44
July–Sept.	378	386	98	344	420	82
Oct.–Dec.	381	383	99	397	377	105

	South of Lat. 55°00′N			All areas		
	Weight landed/ 100 cwt	100 hrs fishing	Weight landed/ 100 hrs	Weight landed/ 100 cwt	100 hrs fishing	Weight landed/ 100 hrs
Jan.–March	4	663	1	1177	1450	81
April–June	13	545	2	1129	1363	83
July–Sept.	80	571	14	803	1376	58
Oct.–Dec.	28	569	5	806	1328	61

Table 36. Landings of haddock by Scottish steam trawlers from the North Sea in 1960

Quarterly period	North of Lat. 57°30′N			Lat. 55°N to 57°30′N			All areas		
	Weight landed/ 100 cwt	100 hrs fishing	Weight landed/ 100 hrs	Weight landed/ 100 cwt	100 hrs fishing	Weight landed/ 100 hrs	Weight landed/ 100 cwt	100 hrs fishing	Weight landed/ 100 hrs
Jan.–March	295	235	126	61	144	42	356	379	94
April–June	262	146	179	104	138	75	366	283	129
July–Sept.	129	98	132	208	144	144	337	242	139
Oct.–Dec.	228	150	152	93	93	100	321	243	132

British statistics

In Table 35 are given the haddock landings from the North Sea by British steam trawlers during 1959. Comparable statistics for Scottish steam trawlers during 1960 are given in Table 36.

R. Jones

WHITING*)

North Sea Stock

Scottish Investigations, 1960

(Tables 37–40)

Age Composition

The age composition ot the whiting captured by F. R. S. "Scotia" in the North Sea during 1960 is shown in Table 37. Three routine trawling cruises were made during the year, but the central area was not visited in the September cruise, and the Firth of Forth area was sampled only during the February/April cruise. The 1958 year-class was well represented in the northern, north central, and central areas, while the 1959 year-class was strong in the inshore areas.

British statistics

A summary of the whiting landings by British steam trawlers from the North Sea in 1959 is given in Table 38. The landings by Scottish trawlers during 1960 are given in Table 39.

Size composition

The mean lengths of whiting sampled in the North Sea during 1960 are given in Table 40.

R. Gambell

*) See also p. 110-11.

Table 37. Age composition of whiting caught by F. R. S. "Scotia" in 1960 per 10 hours' trawling

Area	*Northern*				*North Central*			
Cruise	Feb./Apr.	June	Sept.	All Cruises	Feb./Apr.	June	Sept.	All Cruises
No. of hauls	7	5	10	22	21	7	19	47
Year-class				Weighted means				Weighted means
1960	—	—	14	14	—	—	172	172
1959	31	2	5	13	230	13	290	222
1958	543	44	53	207	923	129	451	614
1957	107	42	85	82	363	49	286	285
1956	21	2	5	9	21	1	14	15
1955	29	22	40	32	49	6	71	51
1954 and older	6	6	9	7	5	1	12	7

Area	*Central*			*Moray Firth and Orkney*				*Firth of Forth*
Cruise	Feb./Apr.	June	All Cruises	Feb./Apr.	June	Sept.	All Cruises	Feb./Apr.
No. of hauls	7	7	14	7	1	4	12	3
Year-class			Weighted means				Weighted means	
1960	—	—	—	—	—	192	192	—
1959	653	34	344	3,234	0	125	1,928	1,047
1958	899	29	464	80	120	2	57	0
1957	504	4	254	79	0	0	46	0
1956	3	0	2	1	0	0	1	0
1955	6	0	3	7	20	0	6	0
1954 and older	0	0	0	3	0	0	2	0

Note: Central area not visited in September.
Firth of Forth area not visited in June or September.

Table 38. Landings of whiting by British steam trawlers in 1959

Area	North of Lat. 57°30′N			Lat. 55°N to 57°30′N		
Quarterly period	Weight landed/ 100 cwt	100 hrs fishing	Weight landed/ 100 hrs	Weight landed/ 100 cwt	100 hrs fishing	Weight landed/ 100 hrs
Jan.–March	425	550	77	71	238	30
April–June	201	458	44	37	360	10
July–Sept.	198	386	51	94	420	22
Oct.–Dec.	340	383	89	86	377	23

	South of Lat. 55°00′N			All Areas		
	Weight landed/ 100 cwt	100 hrs fishing	Weight landed/ 100 hrs	Weight landed/ 100 cwt	100 hrs fishing	Weight landed/ 100 hrs
Jan.–Mar.	16	663	2	512	1,450	35
April–June	14	545	3	252	1,363	18
July–Sept.	31	571	5	323	1,376	23
Oct.–Dec.	21	569	4	447	1,328	34

Table 39. Landings of whiting by Scottish steam trawlers from the North Sea in 1960

Area	North of Lat. 57°30′N			Lat. 55°N to 57°30′N			All Areas		
Quarterly period	Weight landed/ 100 cwt	100 hrs fishing	Weight landed/ 100 hrs	Weight landed/ 100 cwt	100 hrs fishing	Weight landed/ 100 hrs	Weight landed/ 100 cwt	100 hrs fishing	Weight landed/ 100 hrs
Jan.–March	181	235	77	54	144	38	235	379	62
April–June	43	146	29	12	138	9	55	283	19
July–Sept.	40	98	41	45	144	31	85	242	35
Oct.–Dec.	46	150	31	17	93	18	63	243	26

Table 40. Mean length (cm) and range of means of whiting of each age-group from the North Sea in 1960

Area			*Northern*			*North Central*			*Central*		
Year-class	Age	Cruise	Mean	Range of means	No. of fish	Mean	Range of means	No. of fish	Mean	Range of means	No. of fish
1960	0+	Sept.	13.5	13.5	15	12.3	11.4–15.0	293	—	—	—
1959	1+	Feb.–April	18.2	18.1–20.0	22	18.3	15.1–22.0	483	18.3	16.0–21.0	457
		June	25.0	25.0	1	22.2	17.0–25.0	9	20.4	18.8–22.5	24
		Sept.	26.6	25.0–28.0	5	25.6	23.3–27.0	493			
1958	2+	Feb.–April	25.6	25.6–26.7	380	24.9	23.6–26.2	1938	24.3	23.4–26.7	629
		June	27.3	26.8–27.4	22	26.8	25.0–28.0	90	25.0	23.7–25.6	20
		Sept.	30.0	27.0–30.8	58	28.7	26.8–30.6	766			
1957	3+	Feb.–April	30.9	27.8–37.0	75	28.7	26.3–34.9	763	28.1	25.5–29.5	353
		June	31.4	30.0–32.0	21	29.6	28.0–30.1	34	30.7	29.0–33.0	3
		Sept.	31.9	31.1–35.0	93	31.1	28.9–38.0	487			
1956	4+	Feb.–April	30.4	29.2–42.0	15	33.4	26.0–38.0	45	33.5	33.5	2
		June	36.0	36.0	1	29.0	29.0	1	—	—	—
		Sept.	32.6	31.0–36.0	5	30.0	29.0–32.0	23			
1955	5+	Feb.–April	34.4	33.0–36.2	20	34.6	27.0–39.0	102	31.2	31.2	4
		June	34.0	33.0–43.0	11	32.8	32.0–33.0	4	—	—	—
		Sept.	33.7	31.0–36.8	44	32.5	30.0–41.0	120			
1954	6+	Feb.–April	34.7	34.5–35.0	3	36.4	35.0–41.0	5	—	—	—
		June	40.0	36.0–44.0	2	—	—	—	—	—	—
		Sept.	38.2	37.0–38.7	5	36.0	36.0	7			

Area			*Moray Firth and Orkney*			*Firth of Forth*		
Year-class	Age	Cruise	Mean	Range of means	No. of fish	Mean	Range of means	No. of fish
1960	0+	Sept.	13.5	11.7–13.6	77			
1959	1+	Feb.–April	16.8	15.2–21.7	2264	14.6	13.8–15.9	314
		June	—	—	—			
		Sept.	25.4	24.4–26.3	50			
1958	2+	Feb.–April	26.4	25.0–28.0	56	—	—	—
		June	25.8	25.8	12			
		Sept.	35.0	35.0	1			
1957	3+	Feb.–April	30.0	28.3–31.2	55	—	—	—
		June	—	—	—			
		Sept.	—	—	—			
1956	4+	Feb.–April	32.0	32.0	1	—	—	—
		June	—	—	—			
		Sept.	—	—	—			
1955	5+	Feb.–April	35.2	30.5–43.0	5	—	—	—
		June	30.5	30.5	2			
		Sept.	—	—	—			
1954	6+	Feb.–April	31.0	31.0	1	—	—	—
		June	—	—	—			
		Sept.	—	—	—			

German Investigations, 1960

(Tables 41–46)

Sampling of whiting was carried out during three cruises of F. R. S. "Anton Dohrn". In January experimental hauls were made with the herring trawl in the southern North Sea and the eastern part of the English Channel (same areas as in January 1959). During a second cruise in March/April the Dogger Bank area and the north-eastern North Sea were visited. Further investigations in September/October were restricted to the Shields area, Dogger Bank, and German Bight. The mean catches of whiting per 30 min. trawling and the age compositions are given in Tables 41, 43, and 45, the corresponding mean lengths of whiting in each age-group are shown in Tables 42, 44, and 46.

Whiting of the good 1959 year-class were predominant in most of the areas. Also the 1958 year-class was well represented, especially in the German Bight, the Dogger Bank and Shields area as well as in the English Channel and in the north-eastern North Sea. In the three latter areas a considerable proportion of the catches consisted also of whiting belonging to the 1957 year-class.

In September/October catches of 0-group whiting (1960 year-class) were very small in comparison to

Table 41. Mean catch per 30 min. trawling (number of fish) and age composition (%) of whiting caught by F. R. S. "Anton Dohrn" in the North Sea and English Channel in January 1960

(Herring trawl)

Age-group	Year-class	German Bight (54°N–54°30′N, 4°E–8°E)		Southern North Sea[1]) (52°N–53°30′N, 2°E–4°30′E)		English Channel (50°30′N–51°30′N, 0°–2°E)	
0	1959	481	(49)	90	(87)	—	(—)
I	1958	454	(46)	8	(9)	218	(57)
II	1957	47	(5)	4	(4)	121	(31)
III	1956	8	(+)	—	(—)	46	(12)
All ages		990	(100)	102	(100)	385	(100)
Trawl stations		4		3		3	

[1]) converted from catch taken by Perlon herring trawl to that taken by Manila herring trawl (conversion factor: 1.4).

Table 42. Mean lengths of whiting (cm) caught by F. R. S. "Anton Dohrn" in the North Sea and English Channel in January 1960

(Herring trawl)

Age-group	Year-class	German Bight Mean	Range	Number of fish	Southern North Sea Mean	Range	Number of fish	English Channel Mean	Range	Number of fish
0	1959	19.3	10–23	1923	16.5	12–21	192	—	—	—
I	1958	24.5	19–29	1818	23.7	21–25	19	24.6	18–28	653
II	1957	27.4	24–31	186	(28.3)	26–32	9	27.5	20–35	362
III	1956	29.7	28–32	32	—	—	—	33.0	29–43	139

Table 43. Mean catch per 30 min. trawling (number of fish) and age composition (%) of whiting caught by F. R. S. "Anton Dohrn" in the North Sea and Skagerak in March/April 1960

(Herring trawl)

Age-group	Year-class	Viking Bank (59°30′–61°20′N, 1°–4°E)		Utsira (58°–59°30′N, 1°–4°E)		Ling Bank (57°–58°N, 1°–4°E)		Klondyke, Middle Bank, Holmen (N of 57°N, 4°–8°E)	
I	1959	1	(1)	28	(30)	346	(83)	12	(44)
II	1958	23	(35)	40	(45)	55	(12)	5	(17)
III	1957	20	(29)	17	(19)	20	(5)	7	(25)
IV	1956	9	(13)	4	(4)	2	(+)	2	(7)
V	1955	13	(20)	1	(1)	—	(—)	2	(6)
VI+	1954–	2	(2)	1	(1)	—	(—)	+	(1)
All ages		68	(100)	91	(100)	423	(100)	28	(100)
Trawl stations		27		20		13		23	

Age-group	Year-class	Skagerak (E of 8°E)		Jutland Bank (55°30′–57°N, E of 4°E)		German Bight (S of 55°30′N, E of 4°E)	
I	1959	14	(83)	33	(71)	745	(83)
II	1958	1	(6)	12	(26)	125	(14)
III	1957	2	(11)	1	(3)	16	(2)
IV	1956	—	(—)	—	(—)	8	(1)
V	1955	—	(—)	—	(—)	2	(+)
VI+	1954–	—	(—)	—	(—)	—	(—)
All ages		17	(100)	46	(100)	896	(100)
Trawl stations		11		10		9	

Table 45. Mean catch per 30 min. trawling (number of fish) and age composition (%) of whiting caught by F. R. S. "Anton Dohrn" in the North Sea in September/October 1960

(Herring trawl)

Age-group	Year-class	Shields Area		N Dogger		SW Dogger		S Dogger		German Bight		Schlick Bank	
0	1960	21	(5)	+	(+)	19	(5)	+	(+)	38	(5)	+	(+)
I	1959	77	(18)	243	(56)	263	(70)	412	(76)	478	(63)	1105	(67)
II	1958	130	(31)	145	(33)	83	(22)	117	(22)	198	(26)	476	(29)
III	1957	156	(37)	46	(10)	13	(3)	11	(2)	41	(5)	52	(3)
IV+	1956	38	(9)	3	(1)	+	(+)	+	(+)	7	(1)	14	(1)
All ages		422	(100)	437	(100)	378	(100)	540	(100)	762	(100)	1647	(100)
Trawl stations		6		41		24		10		22		6	

Table 44. Mean lengths (cm) of whiting caught by F. R. S. "Anton Dohrn" in the North Sea and Skagerak in March/April 1960
(Herring trawl)

Age-group	Year-class	Viking Bank			Utsira			Ling Bank			Klondyke, Middl Bank, Holmen		
		Mean	Range	Number of fish	Mean	Range	Number of fish	Mean	Range	Number of fish	Mean	Range	Num of f
I	1959	(22.5)	22	1	19.9	13–24	30	18.6	12–24	75	19.3	11–25	9
II	1958	26.6	22–30	72	25.6	21–34	68	24.7	22–29	48	27.2	20–32	5
III	1957	29.1	24–38	57	29.3	24–36	61	27.1	24–34	31	31.5	22–38	8
IV	1956	32.8	28–37	17	35.0	29–39	30	(33.9)	29–36	4	34.1	28–44	2
V	1955	37.0	30–42	25	38.4	33–42	11	—	—	—	37.2	31–44	2
VI+	1954–	(37.1)	35–39	4	(41.6)	35–48	5	—	—	-	(43.5)	39–46	

Age-group	Year-class	Skagerak			Jutland Bank			German Bight		
		Mean	Range	Number of fish	Mean	Range	Number of fish	Mean	Range	Number of fish
I	1959	18.6	11–24	36	16.5	11–22	66	16.6	8–25	107
II	1958	(22.0)	18–27	4	23.5	19–28	69	23.4	20–27	93
III	1957	(30.7)	27–36	5	(28.0)	24–30	5	26.9	24–34	25
IV	1956	—	—	—	—	—	—	30.4	28–35	10
V	1955	—	—	—	—	—	—	(32.6)	29–37	2
VI+	1954–	—	—	—	—	—	—	—	—	—

Table 46. Meanl engths (cm) of whiting caught by F. R. S. "Anton Dohrn" in the North Sea in September/October 1960
(Herring trawl)

Age-group	Year-class	Shields Area			N Dogger			SW Dogger		
		Mean	Range	Number of fish	Mean	Range	Number of fish	Mean	Range	Nur of
0	1960	15.4	11–18	84	—	11–16	+	13.2	7–16	
I	1959	24.7	20–28	307	23.7	16–29	3884	22.7	19–30	10
II	1958	29.1	23–35	520	26.0	21–33	2315	27.1	22–35	3
III	1957	32.4	26–39	627	28.9	25–36	734	32.0	26–37	
IV+	1956–	37.0	31–43	150	33.8	39–44	56	—	36–52	

Age-group	Year-class	S Dogger			German Bight			Schlick Bank		
		Mean	Range	Number of fish	Mean	Range	Number of fish	Mean	Range	Nur of
0	1960	3.5	13	2	11.3	7–15	451	—	9–15	
I	1959	22.5	17–30	1645	21.3	16–28	5747	22.0	16–28	22
II	1958	26.4	22–34	468	25.6	20–33	2371	24.7	20–33	9
III	1957	30.8	25–41	45	29.9	24–38	492	30.0	24–38	1
IV+	1956–	(38.0)	37–38	2	32.9	30–39	86	35.5	30–39	

those of October 1959 (1959 year-class, see Ann. Biol. 16. 1961). The 1960 brood of whiting represented only 5% of the total stock present in the Shields area and SW Dogger as well as in the man Bight. Accordingly, the 1960 year-clas whiting seems to be rather poor.

D. Sahrhage and J. Messtor

Herring

INTRODUCTION

Contributions on the results of work carried out by ten member countries in the I.C.E.S. area in 1960 are included in this report. The contributors are as follows:—

Belgium:
CH. GILIS

Denmark:
AAGE J. C. JENSEN

Germany:
K. SCHUBERT
P. F. MEYER WAARDEN
K. TIEWS

Iceland:
ÁRNI FRIÐRIKSSON

Netherlands:
K. POSTUMA
J. J. ZIJLSTRA

Norway:
FINN DEVOLD
O. DRAGESUND
O. ØSTVEDT

Poland:
H. JANKO
J. POPIEL

Scotland:
B. B. PARRISH
A. SAVILLE
I. G. BAXTER
G. MCPHERSON
J. D. BUCHAN

Sweden:
HANS HÖGLUND

U.S.S.R.:
I. G. YUDANOV
L. P. TELKOVA
I. V. SHUTOVA-KORZH
B. M. TAMBOVTSEV
L. N. LISIVNENKO
L. RANNAK
E. OJAVEER

These contributions provide valuable data on the success of the fisheries and on the size and composition of the exploited stocks in the Distant Northern Seas, Near Northern Seas and Baltic-Belt sub-areas in 1960. Other more detailed statistical and biological data for the North Sea fisheries and stocks have also been published in the ICES *Statistical News Letters*.

The outstanding feature of the Distant Northern Seas fisheries was the continued decline of the Norwegian west coast fishery, based on the Atlanto-Scandian tribe. The Norwegian and Soviet contributions both indicate continued poor recruitment to the spawning stock; further, they do not point to any prospects of an immediate major recovery, due to the appearance of a new large recruit year-class. The Icelandic north coast fishery, based on this tribe, was also poorer than in 1959.

In the North Sea, recruitment by the 1957 year-class was much poorer than that by the 1956 year-class in 1959. This led to relatively poor fishing in the main recruitment areas, and in most areas the fishery was based principally on the strong 1956 year-class. A feature of the fishery in the southern North Sea, which was again poor, was the continued decrease in exploitation by trawlers on the Channel spawning grounds.

B. B. PARRISH

A. Distant Northern Seas

Young Stages

Distribution of 0+ Group Herring off the Murman Coast in 1959 and 1960

(Figure 1)

Work on the estimation of herring fry (*Clupea harengus harengus* L.) in the gulfs, inlets, and within 25 miles of the coast was carried out from the R. V. "Persey-II" in the period 7.—23. October 1959, and in the periods 10. August to 5. September and 4.—17. October 1960. The localities, type, and size of the herring catches are shown in Figure 1.

In the inlets and gulfs and on the shallows, fry were fished with a fine-mesh hauling seine (35 m in length, 3.7 m in height, mesh size in the wings 10 mm—5 mm, in the cod-end, gauge No. 71); in deeper waters the usual 25 m trawl (with 10 mm twine fixed into the trawl bag), the mid-water and ring trawl were used. Analysis of the content of the stomach of trawl-caught cod was also made to detect the presence of herring. All the fishing gears had high fishing capacity, the catches of the fry of cod, saithe, and other fish often amounting to several thousands of specimens. In total, 120 hauls with the seine, 60 with the trawl, 60 with the ring trawl, and 12 with the mid-water trawl were made.

In 1959, 3 specimens of herring (0+) were taken with the seine, in the Pechenga Inlet off Cape Oraniemi. (In addition, 40 specimens of herring were taken from the walls of the purse-seine of the scouting vessel in the same place.) The mean length of the herring was 6.91 cm. The field analysis of the stomach content revealed 29 specimens of (0+) herring in the stomachs of 11 cod (along the entire coast of Murman from Varangerfjord to Svjatoi Noss).

In August 1960, in the Ambarnaya Inlet one herring, 6 cm long, was taken with the seine. In all other inlets herring fry were not found, being absent from the trawl catches also. While carrying out field analyses on feeding cod, one specimen of cod containing 3 specimens of herring (0+ group) in its stomach was caught on 3. September 1960.

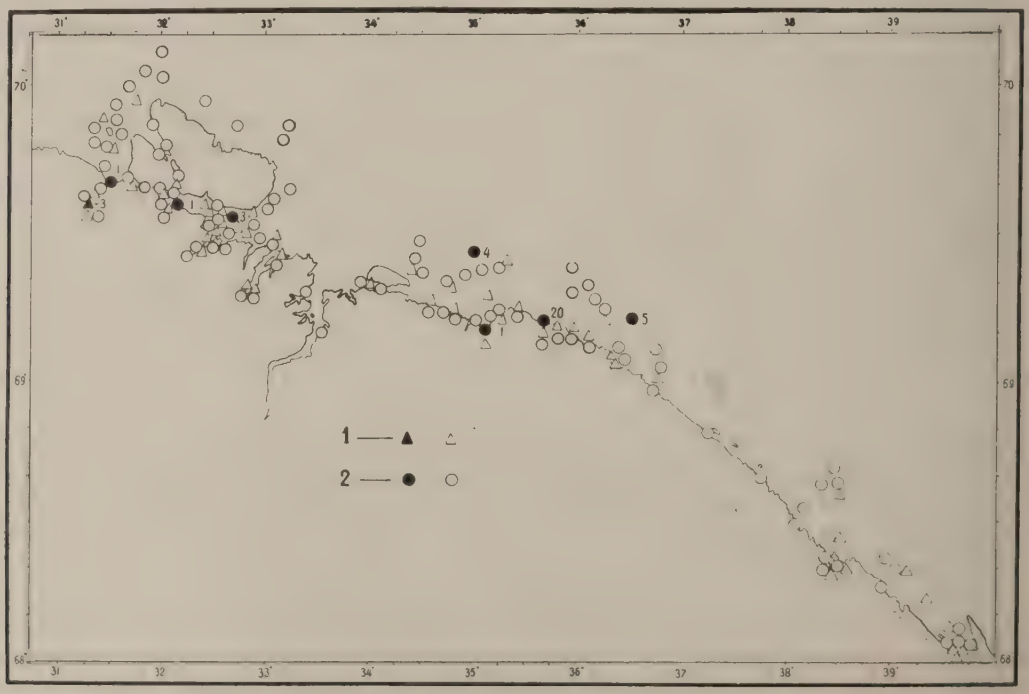

Figure 1. Distribution of 0+ group herring off the Murman coast.
Solid triangles = 0+ group herring of the 1959 year-class; open triangles = no herring.
Solid circles = 0+ group herring of the 1960 year-class; open circles = no herring.

It was taken at 187/170 m depth in the western coastal area, 5—7 miles of the coast.

In October 1960, herring hatched in that year were found in larger numbers than during the October cruise in 1959, but the numbers were still very few in general. On 11. October one herring was caught with the seine in the Teriberka Inlet, and off the Zelenetski Island 20 specimens were taken. The specimens hatched in 1960 were 7.36 cm long on average. In the Motovski Bay and in the western coastal area 0+ group herring were encountered in four trawl hauls, with 3—5 specimens in each of them.

While doing the field analysis, 62 specimens of 1960 year-class herring were found in the stomachs of 33 cod.

Thus, the detail examination of the coastal area showed that the 1959 and 1960 year-classes of herring were met in very small numbers in the gulfs and inlets of the Murman coast. At the same time, on the basis of herring fry estimation throughout the Barents Sea it was established that the 1959 and 1960 year-classes were widely spread in the areas of the open sea.

I. V. Shutova-Korzh

Age and Size Composition of Small Herring of Kandalaksha Bay of the White Sea

(Figure 2)

Small herring of the Kandalaksha Bay, belonging to the race of small herrings of the White Sea are the main object of the herring fisheries in the north-western part of the White Sea. Their distribution is restricted to the Kandalaksha Bay and the Tersky coastal waters, the herring never overpassing their limits.

Besides these herring, having low vertebral counts in the north-western part of the White Sea, herring of high vertebral number, immigrating there, are also caught. But the movement of these high-vertebrae herring into the White Sea is periodic, depending upon the increase of the coastal branch of the Murman Current.

The catches of herring in the north-western part of the White Sea are subjected to sharp changes and have decreased considerably recently. In this connection, we have been carrying on protection of herring on the spawning grounds for more than ten years. During the spring spawning migrations of the small Kandalaksha herring, only test hauls are carried out for the study of the biological composition of the spawning population. The size

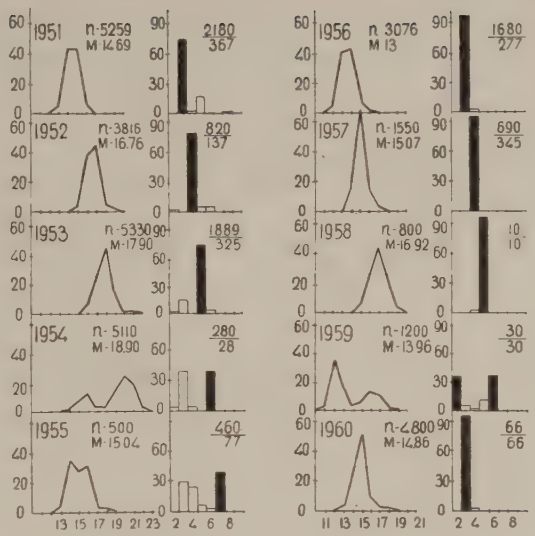

Figure 2. The size and age composition of the spawning population of small Kandalaksha herring (%) and the efficiency of the test catches in the Kandalaksha Bay in 1951/1960 (metric centners).

The numerator = the total catch in metric centners.
The denominator = catch per effort in metric centners.
n = number of specimens examined.
M = mean length of the herring in cm.

and age composition of the spawning population of these herring, and the efficiency of test hauls in the Kandalaksha Bay from 1951 to 1960 are shown in Figure 2.

The length composition of 2—10 year-old herring in the spawning population ranges between 11 and 26 cm, in accordance with the changes in their age composition. But specimens 14—18 cm long aged 3—6 years are predominant.

For the ten years of observation, there have been only two rich year-classes, hatched in 1948 and 1953 respectively, which prevailed in the catches for a number of years. The 1948 year-class recruited at age three, and it remained important for five years, being dominant during three of them. The 1953 year-class predominated in the spawning population for three years, from 1956 to 1958. Other generations were poor.

The fluctuations of the small Kandalaksha herring are so great that the ratio of the most abundant 1953 year-class to the poorest 1955 and 1956 year-classes was about 1:300, and perhaps even more.

The length composition of herring, during the feeding period corresponds to that of the spawning period. The significance of the abundant 1948 and

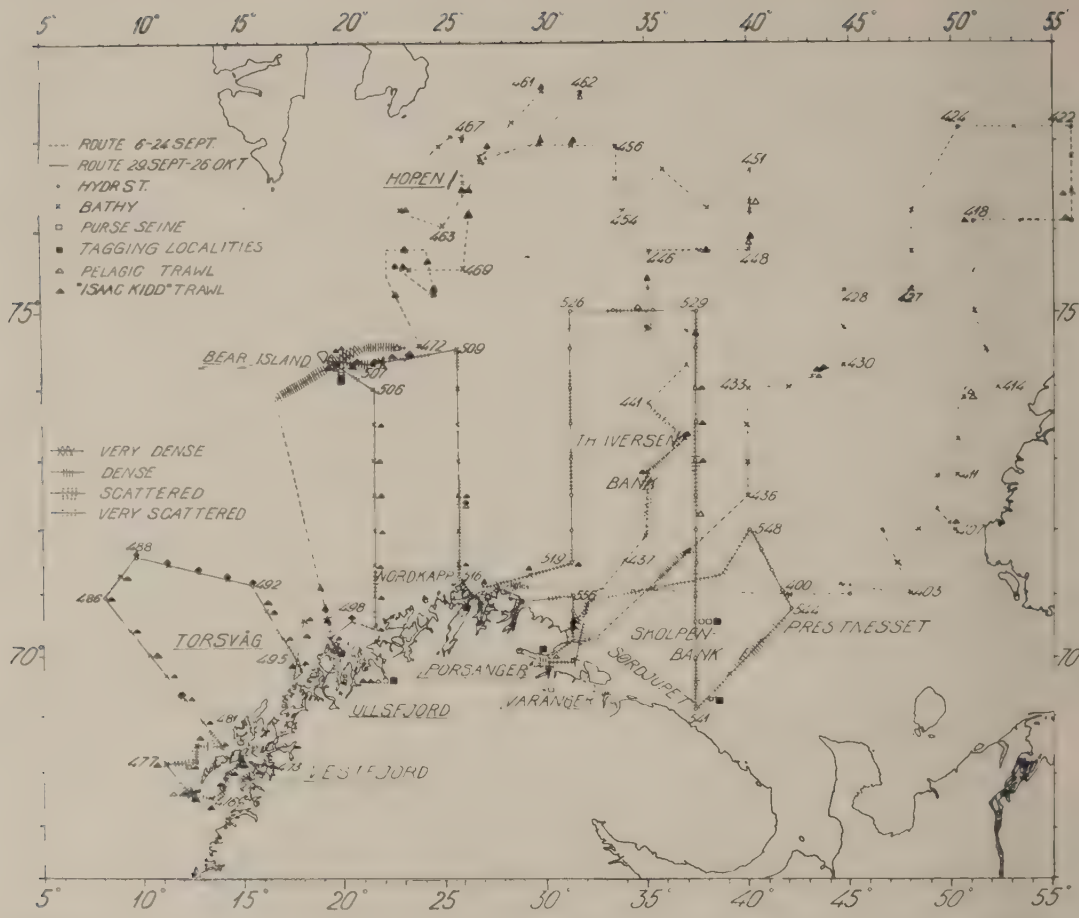

Figure 3. The routes of "G. O. Sars" and the network of stations in September/October 1960. The distribution of 0- and 1-group herring is also shown.

1953 year-classes is quite obvious in the composition of the feeding population.

These plentiful year-classes have considerably improved the state of the resources of small Kandalaksha herring. Nevertheless, this improvement was of temporary character being recently changed by a new decrease in the abundance of herring.

B. M. Tambovtsev

Norwegian Fat and Small Herring Investigations in 1960

(Figures 3–4; Tables 1–2)

The total catch of immature herring landed in Norway in 1960 amounted to 2.860 million hl, 2.203 million hl being taken as small herring and 0.657 million hl as fat herring and 'forfangstsild'. The yields landed in the different areas are shown in Table 1. It will be seen that 78.4% of the small herring were caught in northern Norway (Finnmark/Buholmsråsa) and 16.2% in Møre and Trøndelag (Buholmsråsa/Stad). Only 5.4% was caught south of Stad.

During the first part of the year the 1959 year-class predominated in the catches, whereas the

Table 1. The landings of immature herring in Norway 1960

Area	Small herring Mill. hl	Small herring %	Fat herring Mill. hl	Fat herring %
Finnmark/ Buholmsråsa	1.728	78.4	0.348	53.0
Buholmsråsa/Stad	0.357	16.2	0.283	43.1
Stad/Rogaland ...	0.118	5.4	0.026	3.9
Total	2.203	100.0	0.657	100.0

1960 year-class dominated during the last three months of the year. As shown in Table 1, 53.0% of the fat herring were taken in northern Norway, 43.1% in Møre and Trøndelag, and only 3.9% south of Stad. The corresponding figures for the three districts in 1959 were 26.2%, 54.2%, and 19.6% respectively. The age composition of the fat herring is given in Table 2. The samples from the two southernmost districsts consisted of only the 1959 year-class. This year-class predominated also in the catches in northern Norway, followed by the 1958 and 1957 year-classes.

From the beginning of September to the end of October a cruise was carried out with "G. O. Sars" to the area off northern Norway and in the Barents Sea, to investigate the distribution of immature herring, especially the 0- and I-groups. The routes of the research vessel and the records of herring obtained by asdic and echo-sounder are shown in Figure 3. "G. O. Sars" was equipped with purse-seine and pelagic trawl which made it possible to secure samples of the herring observed, the length compositions of which are shown in Figure 4.

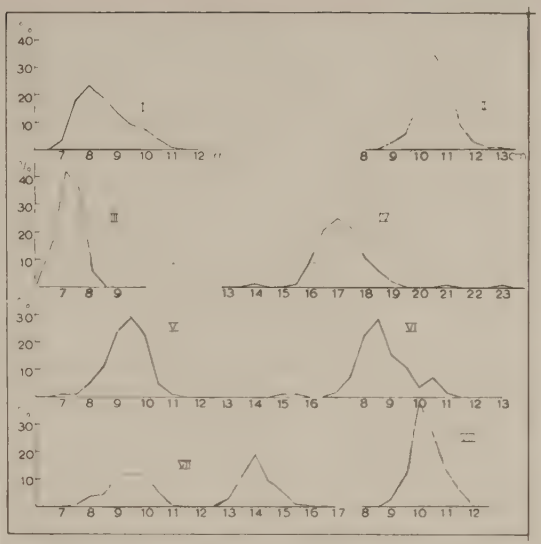

Figure 4. The length distribution of the 0 and I-groups. I, Røst Bank; II, Torsvåg; III, Bear Island; IV, North Cape Bank; V, Skolpen Bank; VI, Central Bank; VII, Sørdjupet; VIII, Varangerfjord.

Table 2. Age composition of fat herring (‰)

Area	Age (winter rings) 1	2	3	4	5	6	7	Tota
Finnmark/Buholmsråsa ..	685	194	99	12	4	4	2	1,000
Buholmsråsa/Stad	1,000	—	—	—	—	—	—	1,000
Stad/Rogaland	1,000	—	—	—	—	—	—	1,000

OLAV DRAGESUND

Adult, Commercial Fish

The Icelandic North Coast Herring in 1960

(Figures 5–6; Tables 3–11)

A. The fishery

Following somewhat improved yields in 1959 as compared with earlier years, the landings were again poorer in 1960. 258 vessels participated, as compared with 224 in the previous season. In spite of this increased effort the total catch was considerably smaller, only 1,220,688 hl (1,597,649 in 1959). The average catch per vessel was therefore much smaller than in 1959, being 4,731 hl as compared with 7,133 hl in 1959.

B. Biological features of the stock

The material for 1960 comprised 45 samples, containing 4,463 fish. All localities from which the samples originated are shown in Figure 5. The catches were scattered over a wide area and the composition of the samples was very heterogeneous. This appears quite clearly from the length compositions in Table 3. Sample No. 2 came from the south coast, which is outside the fishing area.

The data in Table 3 show the average lengths and the length distributions of the herring. It appears that the length decreased from west to east, and

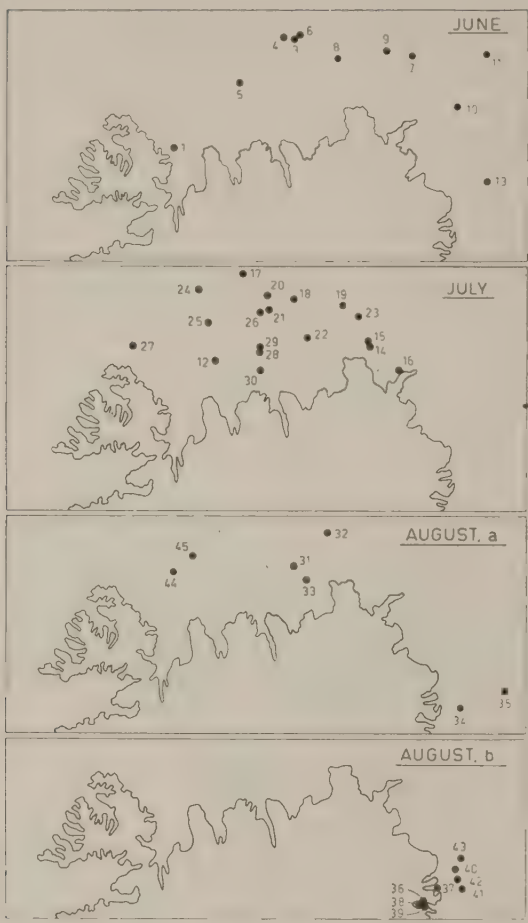

Figure 5. Localities of sampling in 1960.

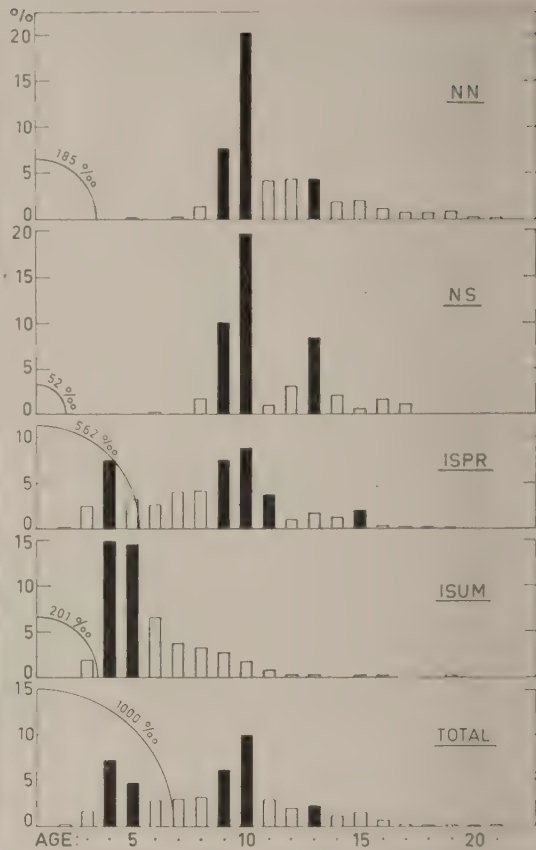

Figure 6. Age distribution of the different tribes in 1960, together with the relative number of fish in each tribe (circles at left)

as time passes. In spite of the fact that the samples in June came from a very wide area, the material was comparatively homogeneous and the herring were very large (36.25 cm). In July several small size groups appeared in the catches and the average length was only 34.47 cm. This development continued through August, when the average length off the north coast (Samples 31—33) was 33.52 cm and off the east coast (Samples 34—35) only 31.86 cm. The two drift-net samples from August also comprised mostly small herring (31.36 cm). Finally, it should be mentioned that samples 36—43, which were collected at the end of the season, on 10. August and later, agree quite well with each other and contain mostly immature herring of the 'fat herring' type. They came from ring-net landings and the average length was 29.59 cm. If we exclude samples 2 and 36—43, the average length of all herring in 1960 was 34.60 cm as seen in Table 3. There has been a tendency to decreasing lengths during the last few years, the average length being 35.69 cm in 1958, 35.07 cm in 1959, and 34.60 cm in 1960.

The racial composition of the catches is shown in Table 4. Samples 2 and 36—43 are omitted from the table. They seem to have contained nearly exclusively Icelandic summer spawners, as the average number of vertebrae was very low (56.926). It ranged from 56.820 to 57.050 for the individual samples. The data in Table 4 show that the Norwegian tribes contributed, on average, 237‰ throughout the season, as compared with 187‰ in 1959. The proportions of Norwegian herring decreased, as usual, from June (350‰) through July (217‰) to August (120‰). The proportion for August would have been a little higher (268‰) if the two

Table 3. Length distribution of north coast herring (‰)

Month	June	July	August	August	August[1])	Total	June	August	Total	Grand Total
Samples	1,3–11,13	12,14–30	31–33	34–35	44–45		2	36–43		
cm 40	2	2	—	—	—	1	—	—	—	1
39	27	15	10	—	—	17	—	—	—	13
38	158	86	27	10	—	94	—	—	—	75
37	**245**	158	112	40	—	**164**	10	—	1	**132**
36	**294**	**196**	**170**	**115**	25	209	20	—	2	**168**
35	189	130	**190**	**95**	20	145	—	1	1	116
34	57	80	81	60	70	71	40	1	6	58
33	20	61	71	55	65	49	60	1	8	41
32	6	74	**121**	45	160	63	60	4	10	53
31	1	86	**150**	100	**305**	**78**	90	3	12	**65**
30	1	77	54	**125**	**285**	66	**170**	28	49	61
29	—	26	14	**140**	50	25	100	43	49	29
28	—	9	—	110	20	12	**140**	89	94	28
27	—	—	—	55	—	3	50	88	83	19
26	—	—	—	50	—	3	40	**203**	**185**	**40**
25	—	—	—	—	—	—	60	**254**	**232**	**47**
24	—	—	—	—	—	—	50	179	163	33
23	—	—	—	—	—	—	90	80	81	16
22	—	—	—	—	—	—	20	16	17	3
21	—	—	—	—	—	—	—	6	4	1
20	—	—	—	—	—	—	—	4	3	1
Total	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
No. of fish	1083	1785	295	200	20	3563	100	800	900	4463
Mean	36.25	34.47	33.52	31.86	31.36	34.60	28.66	25.59	25.74	32.87

[1]) Drift-nets.

Table 4. Relative strengths of the tribes (‰)

Tribes	June	July	August	Total
NN	288	160	97	185
NS	62	57	23	52
ISPR	642	589	395	562
ISUM	8	194	485	201
Total	1,000	1,000	1,000	1,000
Number	927	1,649	661	3,237

drift-net samples, which only contained Icelandic spring (229‰) and summer (771‰) spawners had been omitted. The increasing frequency of summer spawners from June (8‰) to August (485‰) is noted.

The age composition of the samples are shown in Table 5 and Figure 6. There are 20 year-classes in the landings, ranging from 2 to 21 years in age. More than 91% of the herring in samples 2 and 36—43 were 2 and 3 year-old fish and had therefore nothing to do with 'normal' north coast herring. If this fraction of the material is omitted the age composition of the 'total' is similar to that of 1959, as the 1950 and 1954 broods were relatively strong, there were, however, considerably more young fish than in the previous season. If however, each tribe is considered separately, it is clear that remarkable changes have taken place.

The average age of the NN tribe (11.2 years) was a little lower than in 1959 (11.6) and in 1958 (11.9). The outstandig feature was the predominance of 10 year-old herring (1950 year-class), which amounted to 415‰. The two strongest year-classes (1950 and 1951) made up 542‰ of the total of the tribe, as compared with 409‰ in 1959 and 260‰ in 1958. The 1947 brood on the other hand (89‰) was of relatively smaller importance than in 1959 (125‰) and 1958 (146‰).

The average age of the NS tribe (11.2 years) was considerably higher than in 1959 (10.4) and 1958 (10.3) owing to the fact that there were very few young fish. The 1950 and 1951 year-classes made nearly 600‰ of the tribe as compared with 410‰ in 1959, and there were relatively many 13 year-old fish (161‰).

The average age of the Icelandic spring spawners (8.3 years) was much lower than in the previous season (9.0) owing to the appearance of the 1956 year-class, which represented 149‰ of the tribe (28‰ in 1959). There were less old fish, and the 1945 year-class is decreasing rapidly from year to year. It represented 130‰ of the tribe in 1958, 68‰ in 1959, and 35‰ in 1960.

The age composition of summer spawning herring has changed very much since 1959, as the number of 4 and 5 year-olds has increased very much. Whereas in 1959 about 410‰ of this tribe was

Table 5. Age compositions of north coast herring in 1960, according to tribes

Age	Year	NN	NS	ISPR	ISUM	?[1])	Total	Samples 2 and 36–43	Grand Total
2	1958	—	—	6	—	—	3	704	151
3	1957	—	—	49	39	—	32	207	72
4	1956	—	—	149	294	47	144	69	127
5	1955	2	—	67	289	—	96	10	78
6	1954	—	6	51	127	—	55	2	44
7	1953	7	—	80	73	—	61	2	48
8	1952	26	36	83	66	143	67	2	53
9	1951	127	210	149	51	239	124	—	97
10	1950	415	389	175	32	95	200	1	158
11	1949	81	24	74	15	47	61	1	48
12	1948	89	66	18	6	47	37	1	30
13	1947	89	161	31	2	193	44	—	34
14	1946	38	42	24	—	47	22	1	18
15	1945	43	12	35	2	—	28	—	22
16	1944	21	30	9	2	47	11	—	9
17	1943	15	24	+	—	95	5	—	4
18	1942	14	—	+	—	—	3	—	2
19	1941	17	—	+	2	—	4	—	3
20	1940	9	—	—	—	—	2	—	1
21	1939	7	—	—	—	—	1	—	1
Total		1000	1000	1000	1000	1000	1000	1000	1000
Number		581	167	1826	649	21	3244	875	4119
?[2])		13	—	—	1	305	319	25	344
Grand Total		594	167	1826	650	326	3563	900	4463
‰		185	52	562	201	—	1000	—	—
Average age		11.2	11.2	8.3	5.7	11.1	8.4	2.5	7.1

[1]) Scales not fit for determination of type.
[2]) Scales not fit for age reading.

NN = North Norway type
NS = South Norway type
ISPR = Icelandic spring spawners
ISUM = Icelandic summer spawners.

Table 6. Numbers of vertebrae (VS) by tribes

VS	NN	NS	ISPR	ISUM	?	Total	Samples 2 and 36–43	Grand Total
59	20	18	13	3	15	13	7	12
58	234	215	272	169	227	240	149	223
57	652	659	596	611	595	616	630	613
56	89	102	115	203	163	131	199	145
55	5	6	4	14	—	6	13	7
54	—	—	—	—	—	[illegible]	2	[illegible]
Total	1000	1000	1000	1000	1000	1000	1000	1000
Number	594	167	1826	650	326	3563	900	4463
Mean	57.18	57.13	57.18	56.94	57.09	57.12	56.93	57.09
± m	0.02	0.05	0.02	0.03	0.04	0.01	0.02	0.01

6 years old or younger, the corresponding figure for 1960 was 750‰. In good agreement with this development is the decrease in average age from year to year. This was 7.2 years in 1958, 6.9 in 1959, and 5.7 in 1960.

As a consequence of the low average age of the Icelandic tribes, especially the summer spawners, the average age of all north coast herring (samples 2 and 36—43 omitted) was lower than in earlier years, being 8.4 years. It was 9.3 in 1958 and 9.1 in 1959.

Table 6 shows the distribution of vertebral counts etc. for the various tribes. In the NN tribe the vertebral count (57.18) was nearly the same as in 1959 (57.17) and somewhat higher than in 1958 (57.14). In the NS tribe it was lower (57.13) than in the previous year (57.24). Icelandic spring spawners had the same count as in 1959 (57.18), whereas the summer spawners showed a lower count (56.94) than in 1959 (56.96) but exactly the same as in 1958 (56.94). If we disregard samples 2 and 36—43, we find the average number of VS to be 57.12 for all tribes, which is a little lower than in 1959 (57.15).

Table 7. Vertebral differences between the tribes

Tribe	Number	A VS	± m	B ISUM	ISPR	NS
NN ...	594	57.18	0.02	6.0	0.0	1.0
NS ...	167	57.13	0.05	3.2	1.0	—
ISPR .	1826	57.18	0.02	6.0	—	—
ISUM .	650	56.94	0.03	—	—	—

We will now compare the tribes as is done in Table 7, where the differences are indicated under the heading B in relation to the standard deviation of the differences between the tribes. It appears that it is not possible to distinguish between the spring spawning tribes by means of vertebral counts and that the summer spawning tribe is significantly different from all the other tribes.

It is interesting to compare the number of vertebrae by maturity stages as is done in Table 8. Samples 2 and 36—43 are omitted, and so are also the few (4) fish in maturity stage I.

It appears from the table that stages III and IV, containing 1,169 fish, are in full agreement. Their VS counts is 57.16/57.17, showing that they are spring spawners. Stages II, V, and VII, 1,043 fish, must, on the other hand, be summer spawners owing to the low number of VS (56.91/56.96). Stage VIII, which contained half of the material, does not agree with either of these groups. It must be a mixture of spring and summer spawners. If we now compare the VS of the herring in stage VIII in June, July, and August, as is done in Table 9,

Table 9. Comparison of vertebral counts of herring in stage VIII, by month

Month	Number	VS	± m	August	July
June	878	57.16	0.02	5.7	1.3
July	944	57.12	0.02	4.7	—
August	425	56.93	0.03	—	—

Table 10. Average amount of *Calanus* (cm³) in herring stomachs

Period	1957	1958	1959	1960
11.–20. June	11.0	9.4	4.5	15.5
21.–30. June	9.1	10.6	7.8	13.5
1.–10. July	10.5	6.3	10.9	8.7
11.–20. July	6.6	4.8	11.1	0.0
21.–31. July	3.4	8.1	14.4	0.0
1.–10. August	0.9	9.5	10.3	0.0
11.–20. August	0.0	10.0	11.0	?
21.–31. August	0.0	0.0	8.5	?

Table 11. Returns of tagged herring in 1960

A. Returns from north coast factories

Year of Tagging	North coast	East coast	South-west coast	Nor-way	Total
1948	—	—	—	1	1
1949	—	—	—	—	—
1950	—	—	—	—	—
1951	—	1	—	1	2
1952	4	1	—	—	5
1953	5	2	—	—	7
1954	8	—	1	2	11
1955	9	—	1	4	14
1956	—	1	3	1	5
1957	1	2	2	2	7
1958	—	7	1	—	8
1959	45	—	4	—	49
1960	—	—	4	1	5
Total	72	14	16	12	114

B. Returns from east coast factories

1950	—	—	—	1	1
1951	—	2	—	1	3
1952	2	—	—	1	3
1953	2	—	—	—	2
1954	6	—	—	3	9
1955	2	2	—	3	7
1956	3	1	—	1	5
1957	3	12	—	1	16
1958	5	39	—	3	47
1959	32	—	17	1	50
1960	—	122	—	1	123
Total	55	178	17	16	266

C. Returns from south and south-west coast factories

1958	—	1	—	—	1
1959	—	—	18	—	18
1960	—	10	—	—	10
Total	—	11	18	—	29

we come to the conclusion that the stage VIII herring in August (VS = 56.93) belonged to a different group from those in June (57.16) and July (57.12). The August herring consisted of summer spawners, while the June and July ones were mostly spring spawners.

A survey of feeding conditions as revealed by stomach contents, as compared with previous years, is shown in Table 10.

The data for 1960 refer only to the north coast area. There were small quantities of euphausids (1.2—2.2 cm³), as usual. In July, considerable amounts of *Calanus* were observed in single samples far off the north coast; otherwise the main food

Table 8. Numbers of vertebrae by maturity stage

Maturity stage	Number	VS	± m	VIII	VII	V	IV	III
II	896	56.96	0.02	6.5	0.6	0.1	3.3	7.0
III	1095	57.17	0.02	4.0	3.3	2.4	0.2	—
IV	74	57.16	0.06	1.2	2.5	1.9	—	—
V	79	56.95	0.09	1.6	0.3	—	—	—
VII	68	56.91	0.08	2.2	—	—	—	—
VIII	2247	57.09	0.01	—	—	—	—	—

there consisted of *Ammodytes* larvae. A great difference between feeding conditions in 1959 and 1960 is evident. It should finally be mentioned that there were good *Calanus* conditions in the east coast area in August (6.8—13.3 cm³ per stomach).

C. Taggings

Table 11 shows the number of internal tags returned from processing plants in all parts of Iceland in 1960. The total number was 409 tags, which was much less than in 1959 (623). It must be mentioned that some of the Norwegian tags from 1958/59 may originate from Norwegian liberations made in the neighbourhood of Iceland. It is remarkable that one Norwegian tag from 1948 was returned.

Information on herring taggings at Iceland in 1960 is unfortunately not available.

ÁRNI FRIÐRIKSSON

Investigations in the Norwegian Sea and around Iceland in 1960

During the period 3.—20. January 1960 the R/S "G. O. Sars" and "Johan Hjort" were engaged in locating herring schools and mapping the hydrographical conditions during the spawning migration of the herring to the Norwegian coast. A wide area was covered, stretching from Stad to the Lofotens on the Norwegian coast and to about 8°W Long. The "G. O. Sars" worked under the leadership of FINN DEVOLD, and O. J. ØSTVEDT was in charge of "Johan Hjort". The ships met in Kristiansund on 19. January and the temperature conditions in the area investigated was charted. Herring concentrations were found only in the southern part of the area. The schools followed the usual route from north of the Faroes, but were chiefly encountered somewhat to the south of 63°N. The schools arrived in the coastal area north of Stad during the first days of February. The schools moved rather slowly in the cold arctic water (about 6 miles in 24 hours), but as soon as the warm water front had been penetrated the speed was about 30 miles in 24 hours. "G. O. Sars" continued following the herring schools to the Norwegian coast. The main catch was taken off Møre, a few schools only were located south of Stad.

During June 1960 a combined programme was carried out in the Norwegian Sea and the Icelandic waters. The participating ships were "Ternan" of the Faroes, "Ægir" from Iceland, "Johan Hjort" of Norway, and "Perseus II" of the USSR. The results were discussed by the participating scientists on 28.—29. June in Seydisfjord, Iceland. The conclusions were presented to the ICES annual meeting in Moscow 1960.

From 2. June to 8. July a cruise was made with the "G. O. Sars" to Iceland. The purpose of the cruise was to locate the herring and to report to the fishing fleet, which from the beginning of June was stationed on the north coast of Iceland.

During the first part of the cruise the south and west coasts of Iceland were surveyed. On 10. June good concentrations of herring were located at 65°00'N, 26°25'W. No fishing vessels were present in the area and the fish seemed to be migrating fairly quickly southwards. Drift-net samples showed that approximately 75% of the fish were summer spawners in maturity stages IV and V, and the remainder were Icelandic spring spawners in stages VIII and III. Age-groups IV and V were predominant.

On the north coast of Iceland it appeared that the schooling behaviour of the herring changed rapidly during the month of June. Early in that month the herring were spread over a wide area, but during the third week of June large concentrations were encountered in the Polar front area, 80—90 miles north of Iceland. Good catches were taken in this area by about 60—70 purse-seiners until suddenly, a week later, the schools broke up.

By the end of June the fishing fleet moved to the east coast of Iceland where the herring now appeared, in smaller concentrations, however, than previously on the north coast.

Samples of the catches showed that the 1950 year-class was most abundant, comprising between 40% and 55% of the samples. On the north coast the 1947 year-class was also fairly well represented (13%).

On a cruise with "G. O. Sars" to the Norwegian Sea in December (5.—17.) the Atlanto-Scandian herring were located further north and west (65°00'N, 9°00'W) than at the same time in any year since the observations started in 1951. No typical migrating schools were registered and the herring were still found in water with temperature below 5°C, and, at daytime, at a depth of 300 m. The forecast was therefore that the arrival of the herring on the spawning grounds would be late, probably not until February 1961.

During recent years the area of distribution has been reduced in December, a fact which confirms that the stock of adult herring is decreasing every year.

FINN DEVOLD, O. J. ØSTVEDT

Norwegian Winter Herring 1960

(Figure 7; Tables 12–16)

Apart from the war period, the winter herring season in 1960 was the poorest since 1934. The purse-seine landings amounted only to 1.77 mill. hectolitres, the drift-net (including set-net) landings gave 1.45 mill. hl, yielding a total catch of 3.22 mill. hl. Since 1956 the yields have been decreasing, causing more vessels every year to change over to other fisheries. In 1960, 439 purse-seiners and 1,110 drifters participated in the herring fishery, a reduction of 125 purse-seiners and 79 drifters from 1959.

A crude effort statistic and catch per unit effort is given in Tables 12 and 13. The number of herring landed has been estimated from the age distribution in 2-week periods and weighted according to the catch. For the purse-seine fishery the number of vessels and catch per vessel are given, and for the drifters the number of herring per landing. The total number of landings has been calculated from the mean catch per day according to information given by 20—25% of the fleet. From Table 12 and Figure 7 appear that the catch per unit effort for both gears followed the same trend as until 1957 when the catch per unit effort for the purse-seine fishery fell to a much lower level. This must be ascribed to unusually bad weather conditions in 1957 and 1958 and also to lesser availability of herring for the purse-seine fishery due to shifting to more northerly spawning grounds.

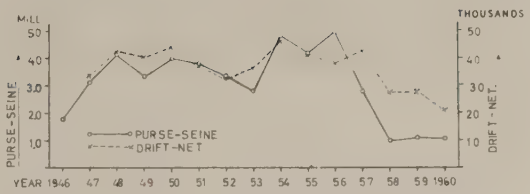

Figure 7. Norwegian winter herring. Catch per unit effort in numbers.

Table 12. Catch and effort statistics for the Norwegian winter herring, purse-seine fishery 1946–1960

Year	Catch 1000 hl	Catch Mill. herring	Effort No. of vessels	Catch per vessel 1000 herring
1946 ...	1450	491.2	273	1798
1947 ...	2488	821.7	261	3148
1948 ...	3526	1251.6	312	4011
1949 ...	3179	1172.7	350	3350
1950 ...	4228	1529.5	385	3973
1951 ...	5531	1667.1	434	3841
1952 ...	5335	1582.4	474	3388
1953 ...	4634	1347.6	482	2796
1954 ...	7870	2381.4	492	4840
1955 ...	6681	2291.6	549	4174
1956 ...	8720	2803.9	561	4998
1957 ...	4905	1665.2	599	2780
1958 ...	1871	576.7	593	972
1959 ...	2207	630.8	564	1118
1960 ...	1770	506.3	439	1153

Table 13. Catch and effort statistics for the Norwegian winter herring, drift-net fishery 1946–1960

Year	Catch 1000 hl	Catch Mill. herring	Effort 1000 landings	Catch per landing 1000 herring
1946 ...	2373	802.3	—	—
1947 ...	2763	913.1	27.1	33.6
1948 ...	4526	1607.9	37.2	42.6
1949 ...	2524	931.7	22.9	40.7
1950 ...	3092	1116.8	25.2	44.3
1951 ...	3888	1171.9	31.2	37.5
1952 ...	3425	1014.7	31.7	32.1
1953 ...	2446	710.8	19.4	36.6
1954 ...	3783	1144.7	24.0	47.6
1955 ...	3601	1234.7	29.9	41.3
1956 ...	3568	1144.4	29.4	38.9
1957 ...	3600	1223.5	28.5	42.9
1958 ...	1833	566.1	20.5	27.6
1959 ...	2265	647.3	23.4	27.7
1960 ...	1450	416.5	20.1	20.6

Table 14.

Length composition of Norwegian winter herring (‰)
A: Stages IV–VIII; B: Total (including stages I–III and herring with scales not fit for age determination)

cm	A Purse-seine	A Drift-net	B Purse-seine	B Drift-net
28.0	—	1	1	1
.5	—	—	—	—
29.0	1	1	1	1
.5	1	—	1	—
30.0	1	1	1	1
.5	—	2	—	2
31.0	1	4	1	4
.5	4	7	4	7
32.0	23	29	23	30
.5	35	49	35	49
33.0	108	129	107	128
.5	118	103	118	103
34.0	175	209	175	209
.5	152	135	151	135
35.0	132	133	132	134
.5	76	57	76	57
36.0	73	69	73	68
.5	37	27	37	27
37.0	34	24	34	24
.5	16	14	16	14
38.0	8	4	9	4
.5	4	2	4	2
39.0	1	—	1	—
	1000	1000	1000	1000
Total number sampled ...	3335	1807	3343	1814

Table 15. Age composition of Norwegian winter herring; maturity stages IV–VIII (‰)

Age	Purse-seine N.type	Purse-seine S.type	Purse-seine Total	Drift-net N.type	Drift-net S.type	Drift-net Total
4	—	6	2	—	8	3
5	—	40	14	—	69	25
6	3	29	12	—	46	18
7	61	61	61	92	113	100
8	10	89	36	14	119	53
9	32	94	53	27	111	58
10	695	545	644	692	416	590
11	16	25	20	17	16	17
12	47	26	40	48	30	41
13	51	43	48	37	20	31
14	16	13	15	12	33	20
15	14	12	13	13	7	11
16	16	10	14	12	8	11
17	13	4	10	6	2	4
18	5	2	4	11	2	7
19	6	1	4	4	—	2
20	7	—	5	7	—	4
21	5	—	3	5	—	3
22	1	—	1	2	—	1
23	2	—	1	1	—	1
Total ...	1000	1000	1000	1000	1000	1000
Number sampled .	2006	1032	3038	1043	610	1653
Scales not fit for age determination			299			158
Immature (Stages I–III)			6			3

Table 16. Distribution of spawning groups of Norwegian winter herring (‰)

Spawning groups	Purse-seine	Drift-net
I	23	35
II	100	114
III	148	175
IV	141	136
V	108	126
VI	222	218
VII	139	90
VIII	28	32
IX	25	19
X	16	18
XI	18	14
XII	13	8
XIII	7	5
XIV	5	6
XV	3	1
XVI	2	3
XVII	1	—
XVIII	1	—
Total	1000	1000
Number sampled ...	2823	1549

The catch per unit effort in 1960 indicate that the stock of spawning herring on the Norwegian coast has been reduced to approximately one-third of the stock present in the period 1954—1957.

The length and age distributions in the samples are given in Tables 14 and 15. The mean length for the purse-seine and drift-net samples were 34.1 cm and 34.0 cm respectively, with a corresponding mean age of 9.8 and 10.3 years. The 1950 year-class was still predominant in the catches and made up nearly 60% of the total. The recruitment to the spawning stock in 1960 was almost negligible, first time spawners constituted less than 3% of the numbers sampled (see Table 16).

O. J. Østvedt

Norwegian Tagging Experiments in 1960

(Tables 17–19)

The tagging localities and the number of each category tagged are listed in Table 17. The land-seine fishery for winter herring failed in 1960 and we had, therefore, to secure live fish for both the large and spring herring taggings from the purse-

Table 17. Taggings in 1960

Area	Date	Number	Number of liberations by type of tag
Large herring			
Skorpeflaket (W of Ålesund)	15/II	400	350 internal 50 external
Ulla (W of Ålesund)	17/II	700	600 internal 100 external
Rundefeltet (W of Ålesund)	19/II	350	300 internal 50 external
Wallabåene (W of Ålesund)	20/II	200	internal
Storholmen (W of Ålesund)	22/II	525	475 internal 50 external
Ona (N of Ålesund)	23/II	611	524 internal 87 external
Spring herring			
Runde (W of Ålesund)	29/II	781	650 internal 131 external
20 n.m. NW of Runde (W of Ålesund)	3/III	486	393 internal 93 external
10 n.m. NW of Storholmen (W of Ålesund)	4/III	486	457 internal 29 external
"Forfangstsild"			
Tyrnevik (W of Bergen)	20–23/V	2100	2000 internal 100 external
"G. O. Sars" — Iceland			
N of Kolbeinsøya	21/VI		150 internal
I-group			
Sørdjupet (Barent Sea)	" 14/X		1000 internal
o-group			
Torsvåg (N of Tromsø)	3/X		2000 internal
Bjørnøya	7/X		2000 internal
NW of Skolpenbank	14/X		1500 internal
Varangerfjord	21/X		1000 internal
Porsangerfjord	23/X		300 internal

Table 18. Number of returns in 1958, 1959, and 1960 from the different experiments
(The within season receveries and tags received from factories without magnets are excluded)

Year of tagging	Category	Number tagged	Recaptures from: The Norwegian winter herring season			The north and east coast herring season off Iceland		
			1958	1959	1960	1958	1959	1960
1948	NH	7,475	—	1	—	1	—	—
1951	NH	3,064	1	2	1	2	3	—
1952	NH	17,308	12	16	5	8	6	11
1953	NH	10,181	10	9	9	7	8	10
1954	NH	8,783	11	11	3	22	22	6
1955	NH	9,241	15	23	4	32	18	11
1956	NH	8,443	23	17	14	48	30	20
1957	NH	7,550	21	23	13	39	38	18
1958	NH	9,594	—	22	21	—	40	47
1959	NH	9,946	—	—	34	—	—	63
	Total		93	124	104	159	165	186
1948	SH	6,018	1	1	—	—	—	—
1949	SH	8,261	1	4	—	1	1	—
1950	LH	9,085	1	5	2	—	—	—
1950	SH	11,215	—	4	1	—	1	—
1951	LH	5,998	1	5	1	—	—	1
1951	SH	9,986	3	9	2	2	—	–
1952	LH	10,295	2	1	3	—	1	—
1952	SH	10,863	20	34	8	1	2	2
1952	FH	7,971	4	3	2	—	—	1
1953	LH	10,080	—	1	1	2	—	—
1953	SH	10,046	3	9	4	—	1	1
1953	FH	8,496	—	1	5	—	—	—
1954	LH	10,042	4	5	2	—	1	2
1954	SH	10,291	12	24	13	2	—	—
1954	FH	14,970	5	5	3	—	—	—
1955	LH	10,045	19	16	8	1	1	5
1955	SH	9,087	4	6	4	—	—	—
1955	FH	13,586	13	16	4	—	—	4
1956	LH	4,998	4	7	10	—	1	1
1956	FH	12,799	9	24	9	—	—	1
1957	LH	9,500	16	16	21	—	2	2
1957	SH	8,450	16	16	18	—	1	—
1957	FH	3,900	6	4	2	1	—	—
1958	SH	9,998	—	62	22	—	2	1
1958	FH	6,200	—	6	11	—	—	1
1959	SH	13,950	—	—	16	—	—	5
1959	FH	8,100	—	—	17	—	—	1
	Total		144	284	189	10	14	28

NH = North and east coast herring. SH = Spring herring.
LH = Large herring. FH = Fat herring and "Forfangstsild".

seiners. All the taggings were carried out north of Stad and outside the skerries.

Also this year the small herring taggings were successful, and the 0-group was tagged both off the Norwegian coast, in the Barents Sea and just south of Bear Island.

The amount of herring caught by the Norwegian fishing fleet off Iceland for oil and meal processing was 645,132 hl compared with 328,574 hl in 1959 and 220,322 hl in 1958. A comparison of the recaptures from this fishery, with those from the Norwegian winter herring fishery is shown in Table 18. In 1960 a total number of 507 internal tags were received from the different factories, 293 during the winter herring season and 214 during the herring season off Iceland. The within season recoveries and tags received from factories which do not posses magnets have not been taken into consideration. Out of 293 recovered tags during the winter herring season, 189 were released as spring and large herring, "forfangstsild" and fat herring; 104 were tagged as north coast herring.

The composition of the recaptures off Iceland this summer shows the same general pattern as the previous year (Table 18). Out of 214 recovered tags 186 had been released off North and East Iceland, whereas only 28 had been tagged off the Norwegian coast.

Table 19. Returns of Icelandic tags in Norwegian waters

Year of tagging	Year of return	Returns	Returns per mill. hl in ‰
1952	1953	257	4.38
1953	1954	282	4.79
1954	1955	122	3.02
1955	1956	161	3.22
1956	1957	89	2.74
1957	1958	21	2.65
1958	1959	22	1.52
1959	1960	34	3.37

By studying the recaptures of north coast tags (Icelandic tags) in Norwegian waters, it will be seen that a gradual decrease in per mille returns per millon hl has taken place since 1954 onwards, with a minimum in 1959 (Table 19).

The reason for this decrease may be the relatively large number of Icelandic spring spawners which have been present off North Iceland during the tagging experiments over the last five years. In 1959, however, it is probable that the influx of Norwegian spring spawners increased due to the rich 1950 year-class. This may also explain the relatively high per mille returns per millon hl in 1960.

O. Dragesund

Soviet Investigations of the Atlanto-Scandian Herring Stock

The stock strength of Atlanto-Scandian herring has fallen off sharply during the last three years. This is the result of the poor replenishment of the herring stock by the broods which have appeared since 1951. During this period no outstanding brood made its appearance. Therefore, there is a great preponderance of the decrease of the adults, due to the natural and fishing mortality, over the replenishment by the new broods from 1956 and especially from 1957.

The stock strength of Atlanto-Scandian herring is subjected to the influence of the intensive Norwegian and Soviet herring fisheries, which have increased from year to year since 1950. It is especially the increasing intensity of the exploitation of the 0- and I-group herring by the Norwegian fishery in the fjords of north-west Norway that has had a great influence on the herring stock. As a result, the rate of decrease of the rich year-classes has increased greatly.

In the prognosis for 1960, the fishing conditions for the herring fishery in the Norwegian Sea were indicated as less satisfactory than in 1959 and 1958. The rich 1950 and 1951 year-classes would be of great importance in the catches, their abundance being predominant throughout all the seasons; the 1950 year-class would remain the most prominent, as during the six previous years. The importance of the 1952 and 1953 year-classes would increase as compared with the 1959 year-class, in spite of their insignificant strength at sexual maturity.

The prognosis emphasized the fact that the reduction of the herring migrations during the summer feeding period, and the distribution of commercially important concentrations of herring over a smaller area, especially in the autumn/winter period, would govern the success of the fishery. There is no reason to expect a considerable stock replenishment by the young year-classes, due to their poor abundance. The year-classes older than the 1950 one, cannot be of great importance as their abundance has decreased due both to the natural mortality and intensive exploitation.

The fishery conditions in 1960 were distinguished by some peculiarities. One of them was the considerable delay in the movement of pre-spawning herring to the main spawning grounds off the west coast of Norway. Fishing in the Norwegian shallow waters region started after the first ten days of February, which is almost two weeks later than the average for the last 15 years. The beginning of this movement and the development of the fishery also took place somewhat further north than usual. The greatest concentrations and the bulk of the spawning took place chiefly on Frøya and Halten Banks. Considerable herring movement was also observed in the region of the Lofoten shallow water, where the bulk of spawning was off the limits of the 200 m isobath.

Judging from larval abundance the spawning efficiency in 1960 was considerably greater than in 1959. A large number of larvae were observed especially in the shelf region, adjacent to the Hebrides.

The second prominent peculiarity in 1960 was the considerable difference in the hydrological conditions. As a result of the oceanographic survey carried out in June, covering the whole of the Norwegian Sea and the south-eastern part of the Greenland Sea, the sharp increase of the influx of Atlantic water and the displacement of the polar front further westward in the zone of the East Greenland and East Icelandic Currents was started. That is why positive anomalies of the temperature conditions were observed in all branches of the Norwegian Current.

Owing to such hydrological conditions the spring processes are specified by early plankton development. In the waters of the continental sand-bar by the Lofotens it started about 15.—20. March. In

the mixed waters of the East Icelandic Current, the biological spring came 3—4 weeks earlier than in 1959. In the south-western regions, the maximum plankton biomass was observed in May/June, which was favourable for intensive herring feeding. In the Norwegian Current the plankton development was rapid and in June/July its bulk occurred at greater depth. Great numbers of Ctenophora and medusae made their appearance in the upper layers. In this connection the feeding herring remained dispersed throughout rather vast areas of the mixed waters near the limits of the East Icelandic Current.

The decrease of the stock strength of the Atlanto-Scandian herring can be seen from the reduction of the feeding and hibernating areas, and from a reduction in the extent and density of certain herring concentrations during all the seasons. With the reduction of the feeding area, the extreme northern regions and the Mona Sill region, which was particularly significant for the summer fishing up to 1956, have lost their importance. The smaller extent and density of the concentrations during the summer months caused the almost complete cessation of the efficient fishery from the end of March to June.

The main feeding of the Atlanto-Scandian herring stock took place more westerly than in previous years, chiefly at the limit of the East Icelandic Current polar waters. As a result of the displacement of the edges of the East Icelandic Current, the autumn/winter distribution of the pre-spawning herring concentrations moved westward and northward.

On the basis of the stock composition, we can say that in 1961 the state of the herring resources will be even less satisfactory than those of the three previous years. The deterioration of the fishing conditions will be felt in consequence of the greater reduction in the herring migrations. The peculiarities of the previous years will be preserved both in the distribution and in the behaviour of the fishing concentrations. The summer herring distribution in the intensive feeding period will be distinguished by a more westerly location. The region adjacent to the north coast of Iceland will therefore be of great importance for the fishery. The autumn/winter concentrations will be distributed over a smaller area, and the movement to the spawning grounds will take place later than in 1960.

The 1950 and 1951 year-classes will be of great significance in the catches, their abundance, at ages 10 and 11 being predominant throughout all the seasons; the 1950 year-class will keep superiority, as during the seven previous years. However, the abundance of these year-classes will be further reduced. Apart from natural mortality, the total catch of this year-class by the Norwegian and Soviet fisheries has amounted to more than 3.5 million tons. But it is necessary to take into account the very large Norwegian catch, of more than 100 milliard individuals, of the small immature and fat members of this year-class. When these are taken into account, the total removals of this year-class exceed those of the rich 1943, 1944, and 1947 year-classes.

As a result of the high reduction in stock strength of all the year-classes older than the 1951 one, the young, relatively poor 1952—1956 year-classes will be of greater importance to the fishery. On the basis of the 0-group records, made in the Barents Sea, we can say that the youngest 1959 and 1960 year-classes are distinguished by a higher abundance than all the year-classes which have appeared since 1951. On the basis of these records the 1959 year-class is a moderate one and the 1960 one is a more than moderate one. Such a combination of two successive year-classes can replenish the Atlanto-Scandian herring stock and improve the state of herring resources, beginning from 1963 and especially in 1965.

In the 1961 prognosis made for the open sea regions of the southern part of the Barents Sea and for the bays of the Murman coast, the state of the fishing resources is not found to be at a high level, but more satisfactory than in 1960. On the basis of the scouting cruises and the catch composition both the 1960 and 1961 prognoses indicated the presence of considerable numbers of the 1959 year-class in the catches.

I. G. Yudanov

Recruitment of the 1950 Year-Class to the Spawning Stock of Atlanto-Scandian Herring

(Tables 20–21)

In recent years, the Polar Research Institute of Marine Fisheries and Oceanography, has carried out investigations on the recruit spawners, of the extremely rich 1950 year-class, to the spawning stock of Atlanto-Scandian herring.

The age of herring at the onset of maturity was determined from scales, using the method of the Norwegian investigators Lea and Runnstrøm.

In 1957, PINRO received from the Institute of Marine Research in Bergen preparations of herring scales, the age of the onset of maturity of each specimen, being indicated. It enabled us to verify the correctness of our determinations.

The material was collected from catches taken

Table 20. The relative number (%) of herring of the 1950 year-class, spawning for the first time at different ages (according to data for 1954/1959)

Years	Age at first spawning							Number of fish examined
	3	4	5	6	7	8	9	
1954	1.2	98.8	—	—	—	—	—	694
1955	0.2	50.0	49.8	—	—	—	—	662
1956	0.5	38.7	44.2	16.5	—	—	—	1,017
1957	0.1	18.7	40.7	19.7	20.8	—	—	1,632
1958	—	20.7	35.8	18.3	20.8	4.4	—	2,644
1959	0.1	19.5	29.5	19.1	27.4	4.3	0.1	2,500

Table 21. The relative number of herring (%) of the 1950 year-class with southern and northern types of scale and spawning for the first time at different ages (according to data for 1957/59)

Years	Type of scale	Age at first spawning							Number of fish examined	Mean age at first spawning
		3	4	5	6	7	8	9		
1957	N	—	11.7	40.0	23.1	25.2	—	—	1,349	5.62
	S	0.4	51.9	43.8	3.9	—	—	—	283	4.51
1958	N	—	11.1	35.7	21.8	26.0	5.4	—	2,116	5.79
	S	—	59.5	36.2	4.3	—	—	—	528	4.45
1959	N	—	6.1	25.4	24.0	38.4	6.0	0.1	1,784	6.13
	S	0.4	52.8	39.7	7.1	—	—	—	716	4.53

by drift-nets during the feeding migrations, to the hibernating places and to the spawning grounds.

Since large-scale ripening of herring is observed from 4 years of age, we began the analysis from the 1954 samples. The recruit spawners are irregularly distributed in the adult stock; therefore we selected the samples containing a larger number of the 1950 year-class compared with other samples. We used the 1954 samples containing about 20% and more of the 1950 year-class, and the 1955, 1956 and 1957 samples, containing approximately 40% of it. Almost all the samples for 1958 and 1959 were included in the analysis.

The members of the year-class were divided into groups, according to the age of onset of maturity (Table 20).

From the 1957/59 data we determined the average age at the onset of maturity of herring with southern and northern types of scales separately (Table 21).

Having analysed data collected during 1954/1959 we came to the conclusion that the recruitment to the spawning stock of Atlanto-Scandian herring by the recruit spawners of the 1950 year-class started chiefly from 1954. Only a small quantity (less than 1%) of herring of this year-class took part in the spawning as 3 year-olds.

Recruitment to the spawning stock by the 1950 year-class was completed by 1959: the recruit spawners at the age of 9 years made up only 0.1% (from the 1959 data).

It is very interesting to note that a great number of herring first took part in the spawning at the age of 7 years constituting approximately 25% of all the specimens of the 1950 year-class included in the analysis.

Herring of the southern, coastal ring type became mature on average one year earlier than those with northern ring type. The mean age at first spawning of the herring with southern type of scale is 4.51 (from the 1957 data), 4.45 according to the 1958 data, and 4.53 according to the 1959 data. For herring with northern scale type the mean age at first spawning (according to the 1957/1959 data) is respectively 5.62, 5.79, and 6.13. The ripening of herring, older than 6 years is observed only among herring belonging to the 1950 year-class with northern, coastal ring type. Herring with southern ring type all became mature by 6 years.

L. P. Telkova

B. Near Northern Seas

Young Stages

Scottish Adolescent Herring Fisheries (0 + I Group)

(Tables 22–25)

A. North Sea

The catch and effort statistics for the 'halflin' fisheries in the Firth of Forth and the upper Moray Firth, during the season 1959/60, are given in Table 22. In the Moray Firth both the total catch and the catch per arrival were higher than has been achieved since the 1956/57 season; whilst in the case of the Firth of Forth the fishery was more productive than any since the 1953/54 season. In both fisheries one-ringed fish made up over 96% of the landings, and of these otolith analysis showed 99% to be of autumn spawned origin.

The size, range, mean length, and mean Vert. S. of the one-ringed autumn spawned fish are given in Table 23. These are in close agreement with similar figures published for previous years.

B. Clyde

The Clyde fishery for adolescent and maturing fish is pursued by ring-net vessels in the period May/January. The bulk of the catches normally come from Kilbrennan Sound and the upper sea lochs, particularly Loch Fyne. The catches are principally composed of spring spawned fish, with a proportion of an autumn-spawning component which varies from year to year.

The catch and effort statistics for the seasons 1955/1960 are given in Table 24. It will be seen that after a series of lean years the total catch rose markedly in 1959, and showed a further increase in 1960. The catch per landing has not shown an altogether parallel trend, largely because of restrictions on landings imposed by limited outlets.

The catch for 1960 was composed of 93% of spring spawned fish. Of these 76% belonged to the 1958 brood, 16% to the 1957 brood, and only 8% to the 1959 brood. The autumn spawning component was also overwhelmingly composed of fish with two winter rings.

The mean lengths and meristic data of the major age-groups of the spring spawning component, as separated by otolith analysis, are given in Table 25. The very small growth increment between 1 and 2 year-old fish is undoubtedly an artifact caused by only the recruitment of the faster growing one year-olds to the commercial catches. The mean Vert. S. figures substantially support the distinction

Table 23. Length and mean Vert. S. of I-group herring in inshore waters off Scottish east coast in 1959–60

Locality	Date	Length range (cm)	Mean (cm)	Mean Vert. S.
		Autumn 1957 brood		
Firth of	Nov. 1959	18–22	19.83 (23)	—
Forth	Dec. 1959	16–22	19.62 (140)	56.47 (184)
(ring-net)	Jan. 1960	17–24	20.37 (93)	56.37 (87)
	Mar. 1960	17–24	20.27 (647)	56.51 (479)
Upper	Nov. 1959	18–23	20.66 (148)	56.52 (141)
Moray	Dec. 1959	18–23	20.81 (246)	56.53 (235)
Firth	Jan. 1960	18–24	20.59 (141)	56.53 (138)
(drift-net)	Feb. 1960	18–24	20.90 (143)	56.51 (136)

Table 22. Statistics of "halflin" fisheries 1955–60

	Season				
	1955–56	1956–57	1957–58	1958–59	1959–60
			Upper Moray Firth		
Duration of season ...	1/10/55–31/3/56	6/10/56–9/2/57	14/9/57–22/2/58	11/10/58–7/2/59	31/10/59–12/3/60
Number of landings ..	2,989	2,274	891	710	1,186
Total catch (crans) ...	61,945	34,605	5,715	5,407	18,056
Catch/landing (crans)	20.7	15.2	6.4	7.6	15.2
			Upper Firth of Forth		
Duration of season ...	24/9/55–31/3/56	8/9/56–16/3/57	21/9/57–19/4/58	10/11/58–21/3/59	28/11/59–9/4/60
Greatest number of boats engaged	16	16	22	16	13
Estimated catch of "halflins" (crans)...	379	328	3,352	1,310	6,417
Estimated catch of "halflins" per arrival (crans)	12.53	6.31	7.56	6.45	12.99

Table 24. Statistics of Clyde adolescent fishery 1955-60

	Season					
	1955	1956	1957	1958	1959	1960
Number of landings	1,575	1,482	3,132	3,186	3,958	5,778
Total catch (crans)	19,070	29,844	20,481	28,550	60,289	72,943
Catch/landings (crans)	12.1	20.1	6.5	9.0	15.2	12.6

Table 25. Length and meristic data of I, II and III group herring in Clyde adolescent fishery in 1959-60

	Rings	Length	Vert. S.	K_2	Pectoral fin
1	Spring spawned	20.20 (192)	56.98 (49)	14.18 (48)	17.35 (51)
	Autumn spawned	21.08 (12)	56.67 (3)	14.67 (3)	17.33 (3)
2	Spring spawned	22.89 (1783)	56.90 (336)	14.30 (247)	17.02 (251)
	Autumn spawned	23.34 (232)	56.56 (89)	14.43 (92)	17.07 (94)
3	Spring spawned	26.32 (336)	57.01 (179)	14.31 (179)	16.90 (181)
	Autumn spawned	25.86 (65)	56.62 (29)	14.39 (28)	17.10 (30)

between the spring and autumn spawning groups made on the basis of the otolith characters. The K_2 and pectoral fin ray counts in the case of this fishery do not appear to provide a basis for racial separation.

A. Saville

The German Oil Herring Fishery in 1960

(Table 26)

In 1960, the low prices for fish meal, led to a considerable decrease in the oil herring fishery. The landings amounted to only 22,391 tons (= 2.01 mill. DM), being half of the catch of 1959, when 40,773 tons were caught. However, during former years, i. e. in 1956 and 1957, catches were occasionally even lower, as shown by the figures below:—

German oil herring landings from 1951 to 1960

Year	Tons	Year	Tons
1951	7,204	1956	22,074
1952	13,712	1957	17,030
1953	26,028	1958	25,894
1954	38,774	1959	40,773
1955	48,670	1960	22,391

The price per kg of oil herring decreased from 0.16 DM in 1959 to 0.09 DM in 1960. Fishing started in July and terminated in October and was carried out on the usual fishing grounds.

As in previous years, the composition of the catch was studied at the Institut für Küsten- und Binnenfischerei. In total, 13 samples, of 2,250 specimens of unsorted catch were investigated as to their species and length composition. The length composition of 1,177 herrings is given in Table 26. In total, 201 million herring were caught by this special fishery.

Table 26. Length distribution (‰) of oil herring in 1960

Month	July	August	September	Total
Number of samples	5	3	5	13
Locality	Clay Deep Upper Scruff	Austern Grund Weiße Bank	Clay Deep Lower Scruff	
Depth (m)	45–48	40–46	42–50	
Length, cm				
13	—	4	—	1
14	—	—	8	3
15	—	4	10	4
16	26	63	20	32
17	158	365	227	225
18	197	365	391	297
19	218	123	222	200
20	245	72	66	147
21	124	4	36	69
22	30	—	15	19
23	2	—	5	3
Total ...	532	253	392	1177

In 1960, the by-catches of non-clupeid fish were greater than usual, due to the abnormal strong abundance of whiting on the fishing grounds, belonging mostly to the 1959 year-class. It may be recalled that an unusual strong abundance of whiting in the German shrimp catch was reported in 1959, when the same year-class, as 0-group was present in the coastal waters (see Ann. Biol., **16** : 253).

The catch composition by species was as follows:—

Species	%
Herring.	52.9
Sprat	21.3
Whiting	24.9
Gurnard	0.3
Mackerel	0.3
Dab	0.2
Others	0.1

Despite the large proportion of whiting in the catch, only 2.7% of the catch consisted of undersized whiting. Most of the fish belonging to the 1959 year-class, and now age-group I, were, namely, at the beginning of the fishing season larger than 20 cm. Another 0.2% of the total catch were undersized dab.

P. F. MEYER-WAARDEN

The Winter Fishery for Juvenile Herring in the Coastal Waters of Niedersachsen in 1959/60

(Tables 27–29)

During the 1959/60 fishing season, an intensive investigation on the so-called 'Spitzen' fishery was conducted at the Institut für Küsten- und Binnenfischerei, in order to gain some further knowledge of the stock composition of juvenile herring being caught along the German coast, their origin, the fishing grounds, the change of fat content during the course of the season (November/March), and the latest development of the fishery in general (TIEWS, 1961 a and b). For this purpose, 63 samples, containing 14,570 specimens were taken from the landings at Greetsiel, Norddeich, Neuharlingersiel, Varelerhafen, Carolinensiel, Cuxhaven, and, for comparison, also at Büsum (Schleswig-Holstein). These samples were analysed as to their length and age composition. Racial studies were conducted on another five samples each of 100 specimens, and finally 124 fat analyses were made.

In 1959/60, 78 coastal fishing cutters were engaged in this special winter fishery, i.e. 28 more than in 1958/59. The total catch amounted to 1,569 tons, mostly of juvenile herring, and to 58 tons of sprat. The herring catch was higher than in 1958/59 (653 tons), but the sprat catch was lower (1958/59 = 100 tons). It is noteworthy to mention that the catch consisted purely of herring and sprat and did not contain other species of fish. The herring is processed for fish meal, the sprat mostly utilized for human consumption.

Table 27. Length distribution (‰) of juvenile herring from coastal waters of Niedersachsen

Length, cm	Nov.	Dec.	Jan.	Feb.	March	Mean
8	3	2	9	13	7	7
9	105	119	62	87	174	98
10	431	446	226	249	514	342
11	302	302	163	193	247	232
12	58	35	95	91	35	67
13	39	19	99	81	11	58
14	34	26	104	97	7	64
15	13	25	101	78	4	56
16	10	15	73	59	1	40
17	3	6	37	27	—	19
18	1	2	12	12	—	7
19	1	1	12	8	—	6
20	—	2	5	3	—	3
21	—	—	2	2	—	1
Number of specimens	1,508	4,355	4,547	2,949	1,211	14,570
Number of samples	5	15	23	13	7	63

As in previous years, the main catch was made during the coldest months of the year; 87% of the herring were taken during January and February. While in 1958/59 the best fishing grounds were located off the islands of Ostfriesland throughout the season, in 1959/60, they slowly shifted from there in a westerly direction to the outer part of the Ems Estuary. The Weser Estuary did not yield any important catch during the two seasons under observation. Average catch per day and boat amounted to 1,785 kg (1959/60) and was thus double the 1958/59 figure (990 kg).

The I-group herring in the catch belonged to a mixture of Bank and Downs spawning groups. In both seasons under investigation (i.e. 1958/59 and 1959/60), two types of herring (I and II), both belonging to the same year-class, could be separated owing to their difference in size distribution. Length type I was characterized by smaller size, which in 1959/60 was between 8 and 12 cm (mode of length distribution = 10 cm). Length type II was then between 12 and 17 cm (mode of length distribution = 14/15 cm) (see also TIEWS, 1961 b). Similar differences between length types were found in 1958/59 when the herring of both types were on

Table 28. Average number of vertebrae (VS) and keeled scales (K_2) of juvenile herring

Date	Catching ground	Number	Length, cm	VS	K_2
3. XII. 58	Near Isle of Neuwerk	100	12.04	56.51	14.91
2. II. 59	Weser Estuary	100	11.81	56.55	15.06
3. III. 59	Near Isle of Langeoog	100	12.30	56.60	15.02
25. XI. 59	Ems Estuary	97	10.51	56.64	14.94
29. XI. 59	Norderpiep near Büsum	100	11.09	56.55	14.95
1. XII. 59	Waddensea near Carolinensiel	99	10.60	56.46	15.15
10. XII. 59	NW of Helgoland	64	14.84	56.42	14.86
14. XII. 59	"P 12"	96	14.08	56.52	14.86

Table 29. Fat content of juvenile herring

Date		below 9 cm	cm grouping 9.0– 11.5 (type I)	12.0– 17.5 (type II)	18.0– 20.5	Total
Nov. 1959	n	—	7	5	—	12
	$\bar{x}$ (%)	—	3.2	5.4	—	4.1
Dec. 1959	n	—	21	9	2	32
	$\bar{x}$ (%)	—	3.0	4.9	12.0	4.1
Jan. 1960	n	—	12	44	1	57
	$\bar{x}$ (%)	—	1.2	4.2	4.1	3.6
Feb. 1960	n	—	6	6	—	12
	$\bar{x}$ (%)	—	1.0	3.7	—	2.4
March 1960	n	1	8	2	—	11
	$\bar{x}$ (%)	1.2	0.6	0.5	—	0.6
November/ March	n	1	54	66	3	124
	$\bar{y}$ (%)	1.2	2.0	4.2	7.3	3.3

the whole about 2 cm longer. The two types seldom mix (TIEWS, 1961 b).

The difference of length between these types may be explained best by the theory that the herring of type II are Bank herring, and the smaller, type I herring are related to the Downs herring or to other herring populations, which spawn two to three months later than the Bank herring. Also, the racial studies being conducted at the Institut für Seefischerei suggest a population mixture of juvenile herrings along the German coast. The average number of vertebrae for the samples were found to be between 56.42 and 56.64 and number of keeled scales between 14.86 and 15.15 (Table 28).

The fat content of the juvenile herring decreased steadily from November to March. It was highest in the larger specimens. In November, the fat content of herring of length type I was, on average, 3.2% and of length type II 5.4%. In March, both types were nearly fat-free, the content averaging only 0.6% (Table 29). It is obvious that the herring were not able to meet their metabolic requirements from feeding at that time and that they had to consume nearly all their fat deposits. This feature has to be considered in relation to the question, why these juvenile herrings approach the coast. In view of the results of fat investigation it may be concluded that they are probably not attracted into the coastal waters by the food supply but more likely, are simply drifted by currents into the coastal area. However, further investigations will be necessary to find an explanation for the annual appearance of juvenile herring in coastal waters of the German Bight during the winter months.

K. TIEWS

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Adult, Commercial Fish

Scottish Fisheries 1960

(Figures 8–11; Tables 30–48)

A. North Sea

The Fisheries

Drift-net

Drift-net fishing during 1960 was carried out from the following Scottish ports: Aberdeen (April to mid-September), Fraserburgh (May to mid-September), Peterhead (mid-May to mid-September), and Lerwick (mid-May to August). There were a few landings at Wick.

The catch and effort statistics for the landings at these ports in 1960 and in the previous three years are given in Table 30.

The drift-net fisheries followed the usual pattern, starting in the north-eastern North Sea in March/April, moving west and south during May, and spreading out over the north-western North Sea from June to August.

The landings at Fraserburgh and Peterhead in 1960 were only half of those in 1959 but this was due principally to a reduction in fishing effort.

Trawl

Herring trawlers, mostly from Sweden, made regular landings at Aberdeen from the north-eastern North Sea (March/June and August/October), from the Fladen ground (April/October) and from the Gut region (October).

The catch and effort statistics for the landings from these grounds in 1960 and the previous three years are given in Table 30. These data show that the total landings were greater but the catch per unit effort was lower than in 1959.

Table 30. East coast and Shetland landings 1957–1960

Drift-net

	Landings (crans)				Arrivals				Average landings per arrival[1]) (crans)			
	1957	1958	1959	1960	1957	1958	1959	1960	1957	1958	1959	1960
Fraserburgh	75,704	54,835	131,012	69,621	4,226	2,552	5,845	3,495	17.9	21.5	22.4	19.9
Peterhead	50,014	21,955	44,746	22,080	2,334	1,064	1,634	1,063	21.4	20.6	27.4	20.8
Lerwick	39,380	40,092	40,772	31,397	1,483	1,718	1,499	1,405	26.6	23.3	27.2	22.4
Wick	44	239	68	21	11	29	9	10	4.0	8.2	7.6	2.1
Aberdeen	60,939	49,883	49,784	33,172	950	862	965	723	64.2	57.9	51.6	45.9

Trawl

	Landings (crans)				Hours fishing				Landing per 100 hours (crans)			
North-eastern North Sea	959	2,086	948	6,326	310	1,064	276	2,177	309.4	196.1	343.5	290.6
Fladen	906	4,709	1,010	8,915	400	2,694	491	5,282	226.5	174.8	205.7	168.8
Gut and southwards	6,199	518	—	1,092	2,136	194	—	397	290.2	269.8	—	275.1

[1]) These figures are not adjusted to standard number of nets per haul. Each arrival at Aberdeen represents on average two hauls, each arrival at other ports usually only one haul.

Biological Data

Drift-net herring

The sampling of the drift-net landings at Aberdeen, Fraserburgh, Peterhead, and Lerwick was carried out as in previous years by examining samples of 50 fish from each day's landings at each port.

North-eastern North Sea (grounds east of 1°E)

The length and age composition of the samples taken from the north-eastern North Sea in 1960 are shown in Figure 8: the maturity, Vert S., K_2, and pectoral fin data are given in Table 31, and the age composition of the spring and autumn spawners (separated on otolith characters) are given in Table 32.

These data show that spring spawned herring consisting mainly of 3-ringed fish (1957 year-class) made a very small contribution to the sampled stocks compared with earlier years (Ann. Biol., **11** and **16**). The autumn spawning group were composed of a wider range of ages dominated by the 3-ringed, 1956 year-class, which made up 68% of the total. The 5-ringed 1954 and the 7-ringed 1952 broods were again prominent (Ann. Biol., **15** and **16**). 2-ringed fish (1957 brood) were very poorly represented.

North-western North Sea (grounds west of 1°E)

The statistical squares sampled each month during 1960 are given in Table 33.

The length and age composition of the samples from these squares are shown in Figure 9, and the

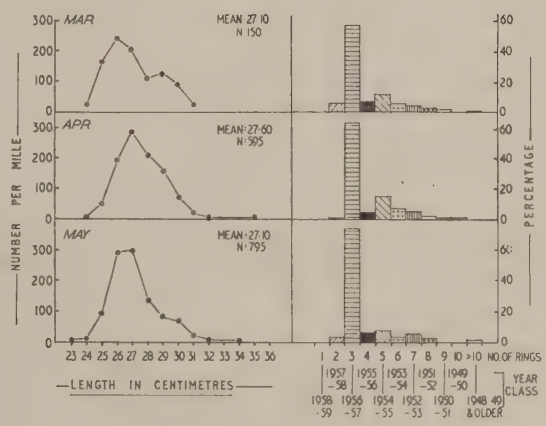


Figure 8. Length and age composition of north-eastern North Sea drift-net samples March/May 1960. (Length frequencies unsmoothed.)

maturity, Vert. S., K_2, and pectoral fin data are given in Table 34.

The age compositions of spring and autumn spawners, resulting from the analysis of otolith characters of the Lerwick samples and some of the Aberdeen samples, are given in Tables 35 to 38.

These data show that the herring stocks fished in the northern part of the north-western North Sea during May to July were of similar composition to those sampled in the north-eastern North Sea from March to May except for a slightly greater

Table 31. Maturity and racial characters — North-eastern North Sea: drift-net 1960

A. Percentage Maturity (All age-groups)

	Maturity Stage I	II	III	IV	V	VI	VII	VII-II	No.
March	10.0	4.0	—	0.7	—	2.7	10.7	**72.0**	150
April	5.2	13.6	0.3	0.2	—	8.1	6.1	**66.2**	595
May	3.1	**46.5**	0.1	0.1	—	—	1.9	**48.2**	795

B. Vert. S. (Actual numbers – All age-groups)

	Number of Vertebrae 54	55	56	57	58	59	Mean	No.
March	—	2	27	19	—	—	56.35	48
April	—	13	95	108	18	—	56.56	234
May	—	5	42	46	2	—	56.47	95

C. K_2 (Actual Numbers – All age-groups)

	Number of Keeled Scales 12	13	14	15	16	17	Mean	No.
March	—	14	22	11	—	—	13.94	47
April	—	59	108	60	6	—	14.06	233
May	1	10	50	24	6	—	14.26	91

D. Pectoral Fins (Actual numbers – All age-groups)

	Number of Pectoral Fins 12	13	14	15	16	17	18	19	20	Mean	No.
March	—	—	—	2	8	21	12	7	—	17.28	50
April	1	—	—	1	35	115	72	17	—	17.27	241
May	—	—	1	1	10	35	44	6	1	17.45	98

Table 32. Age composition of spring and autumn spawners in north-eastern North Sea, between March and May 1960

Spring group: Year-class	Winter rings	Number March	April	May	Autumn group: Year-class	Winter rings	Number March	April	May	Total sample: Number Spring	Autumn	% Spring	Autumn
1958	2	—	1	1	1957	2	9	3	20	2	32	5.9	94.1
1957	3	4	55	26	1956	3	81	322	559	85	962	8.1	91.9
1956	4	—	7	2	1955	4	11	21	46	9	78	10.3	89.7
1955	5	—	3	4	1954	5	18	83	54	7	155	4.3	95.7
1954	6	1	—	1	1953	6	8	42	20	2	70	2.8	97.2
1953	7	—	1	—	1952	7	8	31	36	1	75	1.3	98.7
1952	8	—	—	—	1951	8	4	12	13	—	29	—	100.0
1951	9	—	—	—	1950	9	3	8	1	—	12	—	100.0
1950	10	—	—	—	1949	10	—	5	3	—	8	—	100.0
1949 and older	> 10	—	—	—	1948 and older	> 10	2	1	5	—	8	—	100.0
Total		5	67	34			144	528	757	106	1429	6.9	93.1

Table 33. Statistical squares sampled each month: North-western North Sea: drift-net 1960

	Aberdeen				Fraserburgh				Peterhead				Lerwick	
May ...	20C	20D	19B		15C	14B							21C	20C
	18D	18E	17E										19D	17F
June ...	20B	20C	20D			16C		16E	20C	16C			20C	20D
		17C	17D	17E	15B	15C	15D				14D	14E		19D
		16C	16D	16E	14B		14D	13D			13D	13E	18C	
July ...	19D	17C	16C	16D	16C				16C	15C				19D
	15C	15D	14D	13E	15C					14C	14D			18D
	12D	10C	9D		14C	14D				13C	13D			
Aug. ...	18C	17C	16C	15C	17C	16C	15B	15C	15D	14D				19D
		13C	13D	12D	14B	14C	14D		13C	13D			18C	18D
Sept. ...	13D				15D	14D	13D		13D					

contribution by the 2-ringed 1957—58 broods. In the southern region, during May to July (Table 38), spring spawners made a very small contribution to the stocks and fish with 4 or more winter rings were almost completely absent, 98% of the sampled fish belonging to the 1956—57 (3-ringers) and 1957—58 (2-ringers) year-classes. Spring spawners made even smaller contributions to the Aberdeen samples in August and September.

The mean lengths of 2—5 ringed herring in the

Table 34. Maturity and racial characters – North-western North Sea: drift-net 1960

A. Percentage Maturity (All age-groups)

	Maturity Stage I	II	III	IV	V	VI	VII	VII-II	No.
Aberdeen									
May	1.5	**49.2**	0.2	—	—	—	2.5	**46.5**	400
June	6.0	**79.1**	8.2	1.1	0.1	—	—	5.5	819
July	4.6	**23.5**	**28.2**	**32.6**	7.3	3.5	0.1	0.2	893
August	4.1	4.7	9.8	**32.4**	14.2	17.1	1.1	16.6	829
September	—	—	1.0	—	8.0	11.0	9.0	**71.0**	100
Fraserburgh									
May	20.2	**68.2**	0.4	—	—	—	—	11.1	242
June	10.3	**83.2**	1.8	0.6	—	—	—	4.1	787
July	2.2	19.2	**33.1**	**36.3**	7.6	1.4	—	0.2	1067
August	2.2	4.9	7.2	**29.1**	16.4	18.9	5.3	16.0	779
September	—	—	—	1.7	8.5	**32.3**	20.5	**36.9**	176
Peterhead									
June	7.1	**82.6**	5.7	0.6	—	—	—	4.1	493
July	3.6	22.1	27.3	**39.1**	6.4	1.3	0.1	0.1	993
August	5.9	4.6	8.0	**29.0**	12.4	**23.5**	1.1	15.6	1041
September	2.0	3.6	—	9.7	9.7	13.8	23.1	**38.1**	247
Lerwick									
May	6.5	**36.3**	—	0.4	—	—	3.2	**53.6**	248
June	3.4	**70.5**	7.9	3.7	0.3	0.5	0.6	13.2	1041
July	0.6	10.7	26.1	46.5	12.7	1.8	—	1.5	1087
August	0.3	1.6	1.5	19.3	**30.4**	18.5	19.9	8.5	612

B. Vert. S. (Actual Numbers – All age-groups)

	Number of Vertebrae 54	55	56	57	58	59	Mean	No.
Aberdeen								
May	—	8	81	96	7	2	56.56	194
June	—	11	83	92	3	—	56.46	189
July	—	5	87	85	9	—	56.53	186
August	1	13	110	108	10	—	56.47	242
September	—	—	21	26	—	—	56.55	47
Fraserburgh								
May	—	9	35	44	5	1	56.51	94
June	—	13	78	89	7	—	56.48	187
July	—	6	110	110	5	3	56.53	234
August	—	5	109	110	16	—	56.57	240
September	—	—	25	20	1	—	56.48	46
Peterhead								
June	—	6	79	56	2	—	56.38	143
July	—	4	91	88	7	—	56.52	190
August	—	4	108	111	15	1	56.59	239
September	—	—	23	26	1	—	56.56	50
Lerwick								
May	—	3	16	26	3	—	56.60	48
June	—	4	88	89	9	—	56.54	190
July	—	6	80	97	4	1	56.54	188
August	—	5	43	82	10	—	56.69	140

C. K_2 (Actual Numbers – All age-groups)

	Number of Keeled Scales 12	13	14	15	16	17	18	19	Mean	No.
Aberdeen										
May	2	30	94	52	7	2	—	—	14.20	187
June	3	45	82	50	7	—	—	—	14.07	187
July	—	21	101	64	9	—	—	—	14.31	196
August	—	34	113	66	24	3	—	—	14.37	240
September	—	6	26	15	3	—	—	—	14.30	50
Fraserburgh										
May	2	11	23	8	—	—	—	—	13.84	44
June	1	36	85	40	9	—	—	—	14.12	171
July	2	41	118	59	6	1	—	—	14.13	227
August	4	35	114	73	13	—	—	—	14.23	239
September	—	8	14	17	3	2	—	—	14.48	44
Peterhead										
June	1	25	65	40	5	1	—	—	14.19	137
July	—	31	91	60	6	2	—	—	14.25	190
August	—	40	111	78	14	—	—	—	14.27	243
September	—	10	19	15	3	—	—	—	14.23	47
Lerwick										
May	—	4	17	14	3	—	—	—	14.42	38
June	—	44	87	53	7	1	—	1	14.16	193
July	1	37	91	48	8	1	—	—	14.15	186
August	—	23	66	39	6	2	—	—	14.25	136

D. Pectoral Fins (Actual Numbers – All age-groups)

	Number of Fin Rays 14	15	16	17	18	19	20	Mean	No.
Aberdeen									
May	—	—	26	84	64	20	—	17.40	194
June	—	1	27	75	79	12	—	17.38	194
July	1	2	30	96	49	13	3	17.24	194
August	1	4	39	100	91	12	—	17.26	247
September	—	—	4	22	19	4	1	17.52	50
Fraserburgh									
May	—	—	11	42	36	9	—	17.44	98
June	—	—	21	78	78	15	—	17.45	192
July	—	5	28	81	101	23	1	17.47	239
August	1	1	24	105	99	14	—	17.40	244
September	—	2	8	23	13	—	—	17.02	46
Peterhead									
June	1	2	22	64	49	8	—	17.25	146
July	—	3	22	74	80	14	—	17.41	193
August	1	4	35	103	85	16	1	17.30	245
September	—	—	8	21	14	4	2	17.41	49
Lerwick									
May	—	1	3	21	23	1	1	17.46	50
June	—	3	19	78	82	17	1	17.47	200
July	—	2	21	72	70	28	—	17.52	193
August	—	1	14	44	62	18	1	17.61	140

Table 35. Age composition of spring and autumn spawners at Shetland between May and July 1960

Spring group					Autumn group					Total sample			
Year-class	Winter rings	Number May	June	July	Year-class	Winter rings	Number May	June	July	Number Spring	Autumn	% Spring	Autumn
1958	2	1	14	10	1957	2	29	107	93	25	229	9.8	90.2
1957	3	22	79	19	1956	3	110	607	767	120	1484	7.5	92.5
1956	4	—	5	4	1955	4	13	32	40	9	85	9.6	90.4
1955	5	4	4	1	1954	5	28	71	75	9	174	4.9	95.1
1954	6	—	—	—	1953	6	11	40	31	—	82	—	100.0
1953	7	—	—	—	1952	7	15	47	23	—	85	—	100.0
1952	8	—	1	—	1951	8	8	7	4	1	19	5.0	95.0
1951	9	1	—	—	1950	9	1	9	10	1	20	4.8	95.2
1950	10	—	—	—	1949	10	2	10	3	—	15	—	100.0
1949 and older	> 10	—	—	—	1948 and older	> 10	2	2	4	—	8	—	100.0
Total		28	103	34			219	932	1,050	165	2,201	7.0	93.0

Table 36. Age composition of spring and autumn spawners at Shetland in August 1960

Spring group			Autumn group			Total sample	
Year-class	Winter rings	Number	Year-class	Winter rings	Number	% Spring	Autumn
1958	2	2	1957	2	17	10.5	89.5
1957	3	17	1956	3	313	5.2	94.8
1956	4	2	1955	4	15	11.8	88.2
1955	5	1	1954	5	107	0.9	99.1
1954	6	2	1953	6	25	7.4	92.6
1953	7	1	1952	7	51	1.9	98.1
1952	8	2	1951	8	21	8.7	91.3
1951	9	—	1950	9	19	—	100.0
1950	10	—	1949	10	3	—	100.0
1949 and older	> 10	—	1948 and older	> 10	8	—	100.0
Total		27	Total		579	4.5	99.5

samples at Fraserburgh and Peterhead in 1960, and in earlier years were as follows:—

Year	Age (winter rings) 2	3	4	5
1950	24.51	24.92	26.05	27.73
1951	24.73	25.76	25.93	26.49
1952	24.86	26.25	26.82	27.26
1953	24.54	26.37	27.00	28.09
1954	24.69	26.92	28.12	28.71
1955	24.18	26.81	28.68	29.34
1956	24.76	26.97	28.36	29.43
1957	24.28	26.16	28.30	29.31
1958	24.51	26.76	28.09	28.97
1959	24.88	26.28	28.25	29.25
1960	24.57	26.14	27.75	28.86

Trawled herring

Samples were taken throughout 1960 from herring trawlers landing at Aberdeen from a very wide area and the data from these samples have been grouped by statistical squares in each month. The length and age composition are given in Table 39 and the maturity, Vert. S., K_2, and pectoral fin ray compositions in Table 40.

These data show that the 3-ringed, 1956—57 broods dominated the trawl fisheries as well as the drift-net fisheries in both the north-eastern and north-western North Sea.

B. West Coast

The Fisheries

Minch

In 1960 herring fishing in the Minch was conducted mainly from the ports of Stornoway, Ullapool, and Gairloch in the North Minch, and Mallaig and Oban in the South Minch.

As in previous years catches were made by drift-net and ring-net.

The landing statistics for the North and South Minch areas for 1960 and the three previous years (1957—59) are given in Table 41.

This table shows that the total yield from the drift- and ring-net fisheries in 1960 was lower than in 1959 and 1958 but was still considerably higher than in 1957.

The decrease in the landings occurred mainly in the North Minch drift-net fishery. The combined

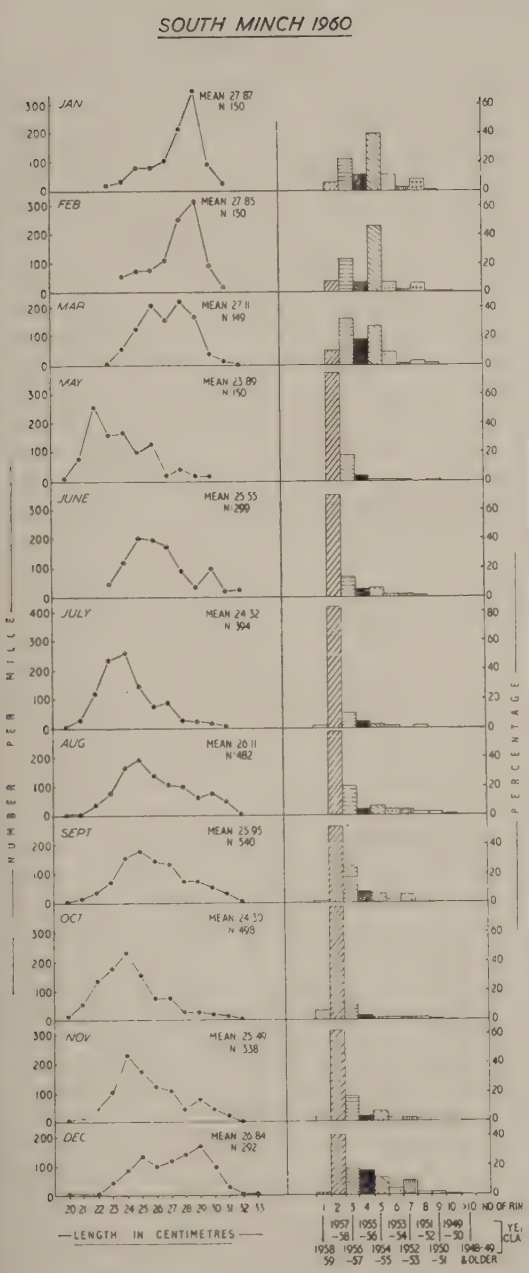


Figure 9. Length and age composition of north-western North Sea drift-net samples May/September 1960. (Length frequencies unsmoothed.)

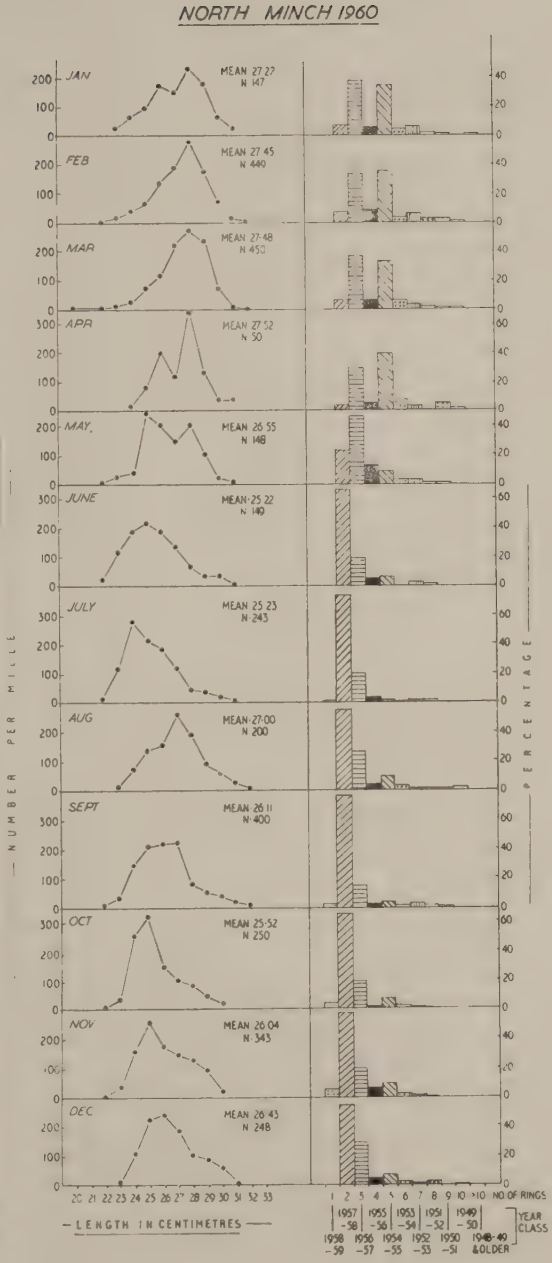


Figure 10. Length and age composition of North Minch drift-net samples January/December 1960. (Length frequencies unsmoothed.)

Table 37. Age composition of spring and autumn spawners in Aberdeen samples from north-western North Sea N of 59 N, May to July 1960

Spring group					Autumn group					Total sample			
Year-class	Winter rings	Number May	Number June	Number July	Year-class	Winter rings	Number May	Number June	Number July	Number Spring	Number Autumn	% Spring	% Autumn
1958	2	1	10	3	1957	2	6	95	14	14	115	10.9	89.1
1957	3	30	16	1	1956	3	229	241	43	47	513	8.4	91.6
1956	4	2	2	—	1955	4	21	8	2	4	31	11.4	88.6
1955	5	1	—	—	1954	5	62	31	6	1	99	1.0	99.0
1954	6	—	1	—	1953	6	13	6	—	1	19	5.0	95.0
1953	7	1	—	—	1952	7	21	11	—	1	32	3.0	97.0
1952	8	2	1	—	1951	8	8	4	—	3	12	20.0	80.0
1951	9	—	—	—	1950	9	1	4	—	—	5	—	100.0
1950	10	—	—	—	1949	10	—	2	—	—	2	—	100.0
1949 and older	> 10	—	—	—	1948 and older	> 10	2	—	—	—	2	—	100.0
Total		37	30	4			363	402	65	71	830	7.9	92.1

Table 38. Age composition of spring and autumn spawners in Aberdeen samples from north-western North Sea S of 59 N, May to July 1960

Spring group					Autumn group					Total sample			
Year-class	Winter rings	Number May	Number June	Number July	Year-class	Winter rings	Number May	Number June	Number July	Number Spring	Number Autumn	% Spring	% Autumn
1958	2	—	11	7	1957	2	—	94	282	18	376	4.6	95.4
1957	3	—	2	1	1956	3	—	266	420	3	686	0.4	99.6
1956	4	—	—	—	1955	4	—	5	3	—	8	—	100.0
1955	5	—	—	1	1954	5	—	4	2	1	6	14.3	85.7
1954	6	—	—	—	1953	6	—	—	1	—	1	—	100.0
1953	7	—	—	—	1952	7	—	1	1	—	2	—	100.0
1952	8	—	—	—	1951	8	—	—	—	—	—	—	—
1951	9	—	—	—	1950	9	—	—	—	—	—	—	—
1950	10	—	—	—	1949	10	—	—	1	—	1	—	100.0
1949 and older	> 10	—	—	—	1948 and older	> 10	—	—	—	—	—	—	—
Total		—	13	9			—	370	710	22	1080	2.0	98.0

Table 39. Length and age composition – trawled herring 1960

A. Length composition (‰)

	Stat. Square	Length (cm) 20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	Mean	No
March	20G	—	—	—	20.0	150.0	180.0	170.0	190.0	110.0	100.0	60.0	—	20.0	—	—	26.53	10
	20H	—	—	—	—	20.0	33.3	213.3	240.0	146.7	106.7	173.3	66.7	—	—	—	27.81	15
April	17F	—	—	—	—	—	160.0	80.0	160.0	100.0	180.0	220.0	80.0	20.0	—	—	28.14	5
July	15E	—	—	—	—	—	—	—	100.0	160.0	140.0	280.0	260.0	40.0	—	20.0	29.66	5
August.....	19E	—	—	—	—	—	—	21.3	234.0	127.7	191.5	297.9	63.8	42.6	21.3	—	28.98	4
	17E	—	—	—	—	—	80.0	160.0	340.0	160.0	100.0	100.0	40.0	20.0	—	—	27.66	5
	15E	—	4.1	—	—	4.1	52.8	138.2	235.8	203.3	126.0	142.3	73.2	16.3	—	4.1	28.00	24
	13D	—	—	—	—	—	—	21.7	130.4	152.2	108.7	195.7	282.6	87.0	21.7	—	29.63	4
September .	17E	—	—	—	10.0	50.0	130.0	190.0	280.0	170.0	80.0	40.0	20.0	30.0	—	—	27.04	10
	16E	—	—	40.0	—	—	100.0	280.0	320.0	160.0	40.0	40.0	20.0	—	—	—	26.76	5
	15E	4.0	—	—	—	12.0	68.0	160.0	312.0	204.0	108.0	92.0	20.0	20.0	—	—	27.52	25
	14F	20.0	—	—	—	40.0	180.0	320.0	300.0	40.0	60.0	20.0	20.0	—	—	—	26.36	5
	13E	—	—	—	—	—	—	80.0	200.0	220.0	160.0	200.0	60.0	40.0	20.0	20.0	28.76	5
October ...	17E	—	—	—	5.0	20.1	135.7	306.5	271.4	110.6	70.4	50.3	10.1	15.1	—	5.0	26.87	19
	17G	—	—	—	—	—	60.0	160.0	420.0	220.0	40.0	100.0	—	—	—	—	27.32	5
	16G	—	—	40.0	—	40.0	140.0	380.0	180.0	80.0	—	60.0	40.0	40.0	—	—	26.64	5
	15E	—	3.0	5.9	14.8	44.4	133.1	281.1	260.4	127.2	47.3	50.3	23.7	8.9	—	—	26.72	338
	14F	—	—	20.0	—	—	20.0	200.0	180.0	240.0	140.0	100.0	80.0	—	20.0	—	27.92	5
	13D	—	10.0	—	—	—	20.0	110.0	320.0	260.0	160.0	70.0	40.0	—	10.0	—	27.80	10
	12F	—	—	—	—	—	60.0	260.0	320.0	200.0	80.0	20.0	40.0	20.0	—	—	27.30	5

Table 39 (continued)
B. Age composition (%)
Number of winter rings

	Stat. Square	1	2	3	4	5	6	7	8	9	10	>10	No.
March	20G	—	5.0	**62.0**	6.0	15.0	2.0	4.0	2.0	2.0	1.0	1.0	100
	20H	—	—	**55.3**	4.7	13.3	4.7	12.7	3.3	2.7	2.0	1.3	150
April	17F	—	—	**38.0**	4.0	4.0	6.0	**22.0**	6.0	6.0	4.0	10.0	50
July	15E	—	2.0	**24.0**	—	**28.0**	10.0	18.0	10.0	2.0	—	6.0	50
August	19E	—	2.1	**44.7**	12.8	6.4	4.3	17.0	6.4	2.1	2.1	2.1	47
	17E	—	12.0	**64.0**	6.0	6.0	—	2.0	6.0	—	4.0	—	50
	15E	—	14.7	**42.9**	9.8	8.6	6.5	10.6	2.5	1.6	0.8	2.0	245
	13D	—	—	**30.4**	2.2	8.7	4.4	**23.9**	13.0	6.5	4.4	6.5	46
September ...	17E	—	20.8	**66.7**	1.0	3.1	—	5.2	2.1	1.0	—	—	96
	16E	2.0	18.4	**65.3**	4.1	6.1	—	2.0	—	—	2.0	—	49
	15E	0.4	10.9	**67.7**	4.4	5.2	3.2	4.8	0.8	0.8	1.2	0.4	248
	14F	2.1	27.1	**60.4**	—	2.1	—	8.3	—	—	—	—	48
	13E	—	4.0	**64.0**	4.0	4.0	14.0	6.0	4.0	—	—	—	50
October	17E	1.0	25.4	**58.4**	2.5	6.1	1.5	3.6	0.5	—	0.5	0.5	197
	17G	—	18.4	**71.4**	2.0	4.1	—	2.0	2.0	—	—	—	49
	16G	6.0	28.0	**50.0**	2.0	2.0	2.0	4.0	—	2.0	2.0	2.0	50
	15E	1.2	26.3	**57.4**	1.8	5.4	3.3	2.7	0.6	0.3	0.6	0.3	331
	14F	2.0	10.0	**44.0**	10.0	10.0	6.0	8.0	2.0	2.0	2.0	4.0	50
	13D	1.0	10.0	**64.0**	6.0	7.0	5.0	5.0	1.0	—	—	1.0	100
	12F	—	14.0	**76.0**	2.0	2.0	2.0	4.0	—	—	—	—	50

Table 40. Maturity and racial characters – trawled herring 1960

A. Percentage Maturity (All age-groups)

	Stat. Square	*Maturity Stage* I	II	III	IV	V	VI	VII	VII-II	No.
March	20G	9.0	—	—	—	—	—	13.0	**78.0**	100
	20H	4.0	2.0	0.7	2.0	—	—	4.7	**86.7**	150
April	17F	6.0	—	—	—	—	2.0	—	**92.0**	50
July	15E	—	6.0	—	16.0	**44.0**	**34.0**	—	—	50
August	19E	—	17.0	—	10.6	12.8	**27.7**	6.4	**25.5**	47
	17E	2.0	6.0	2.0	**26.0**	—	12.0	18.0	**34.0**	50
	15E	4.1	3.7	4.5	**24.4**	18.3	18.3	8.9	17.9	246
	13D	—	—	—	—	—	100.0	—	—	46
September ..	17E	2.0	9.0	—	1.0	—	—	8.0	**80.0**	100
	16E	4.0	—	—	—	—	6.0	24.0	**66.0**	50
	15E	2.0	4.8	2.0	4.0	3.6	2.8	**42.8**	**38.0**	250
	14F	6.0	—	—	—	2.0	2.0	2.0	**86.0**	50
	13E	—	14.0	6.0	—	—	2.0	6.0	**72.0**	50
October	17E	3.0	4.0	0.5	—	0.5	—	25.1	**66.8**	199
	17G	2.0	10.0	—	—	—	—	14.0	**74.0**	50
	16G	10.0	2.0	—	—	2.0	4.0	**74.0**	8.0	50
	15E	4.7	4.4	0.3	—	0.3	—	**45.0**	**45.3**	338
	14F	2.0	—	—	2.0	2.0	—	**76.0**	18.0	50
	13D	5.0	4.0	4.0	—	—	—	32.0	**55.0**	100
	12F	—	4.0	2.0	—	—	—	**90.0**	4.0	50

B. Vert. S. (Actual Numbers – All age-groups)

	Stat. Square	*Number of Vertebrae* 55	56	57	58	59	Mean	No.
March	20G	2	47	43	7	—	56.56	99
	20H	1	40	52	6	—	56.64	99
April	17F	—	—	—	—	—	—	—
July	15E	—	20	28	2	—	56.64	50
August	19E	—	—	—	—	—	—	—
	17E	—	—	—	—	—	—	—
	15E	4	43	46	1	1	56.49	95
	13D	—	—	—	—	—	—	—
September ..	17E	—	—	—	—	—	—	—
	16E	—	—	—	—	—	—	—
	15E	2	62	75	8	—	56.61	147
	14F	—	—	—	—	—	—	—
	13E	—	—	—	—	—	—	—
October	17E	2	23	31	3	—	56.51	49
	17G	—	18	30	1	—	56.65	49
	16G	—	—	—	—	—	—	—
	15E	—	43	50	5	—	56.61	98
	14F	—	—	—	—	—	—	—
	13D	1	18	24	7	—	56.74	50
	12F	—	—	—	—	—	—	—

C. K_2 (Actual Numbers – All age-groups)

	Stat. Square	*Number of Keeled Scales* 11	12	13	14	15	16	17	Mean	No.
March	20G	—	2	16	47	28	4	1	14.19	98
	20H	—	1	25	54	19	1	—	1394	100
July	15E	—	—	9	27	11	2	—	14.12	49
August	15E	1	—	16	29	37	9	1	14.42	93
September ..	15E	—	1	20	65	45	4	1	14.25	136
October	17E	—	—	9	15	10	3	—	14.19	37
	17G	—	—	7	29	10	2	—	14.15	48
	15E	—	1	18	50	23	5	1	14.16	98
	13D	—	—	9	25	14	—	—	14.10	48

D. Pectoral Fins (Actual Numbers – All age-groups)

	Stat. Square	*Number of Fin Rays* 14	15	16	17	18	19	20	Mean	No.
March	20G	1	—	18	32	41	8	—	17.36	100
	20H	—	3	14	41	36	6	—	17.28	100
July	15E	—	1	4	22	17	3	—	17.36	47
August	15E	—	2	17	37	31	9	—	17.29	96
September ..	15E	—	—	17	56	66	10	1	17.48	150
October	17E	—		2	22	18	7	—	17.61	49
	17G	—	—	4	19	21	6	—	17.58	50
	15E	—	2	11	50	27	10	—	17.32	100
	13D	—	1	3	22	22	2	—	17.42	50

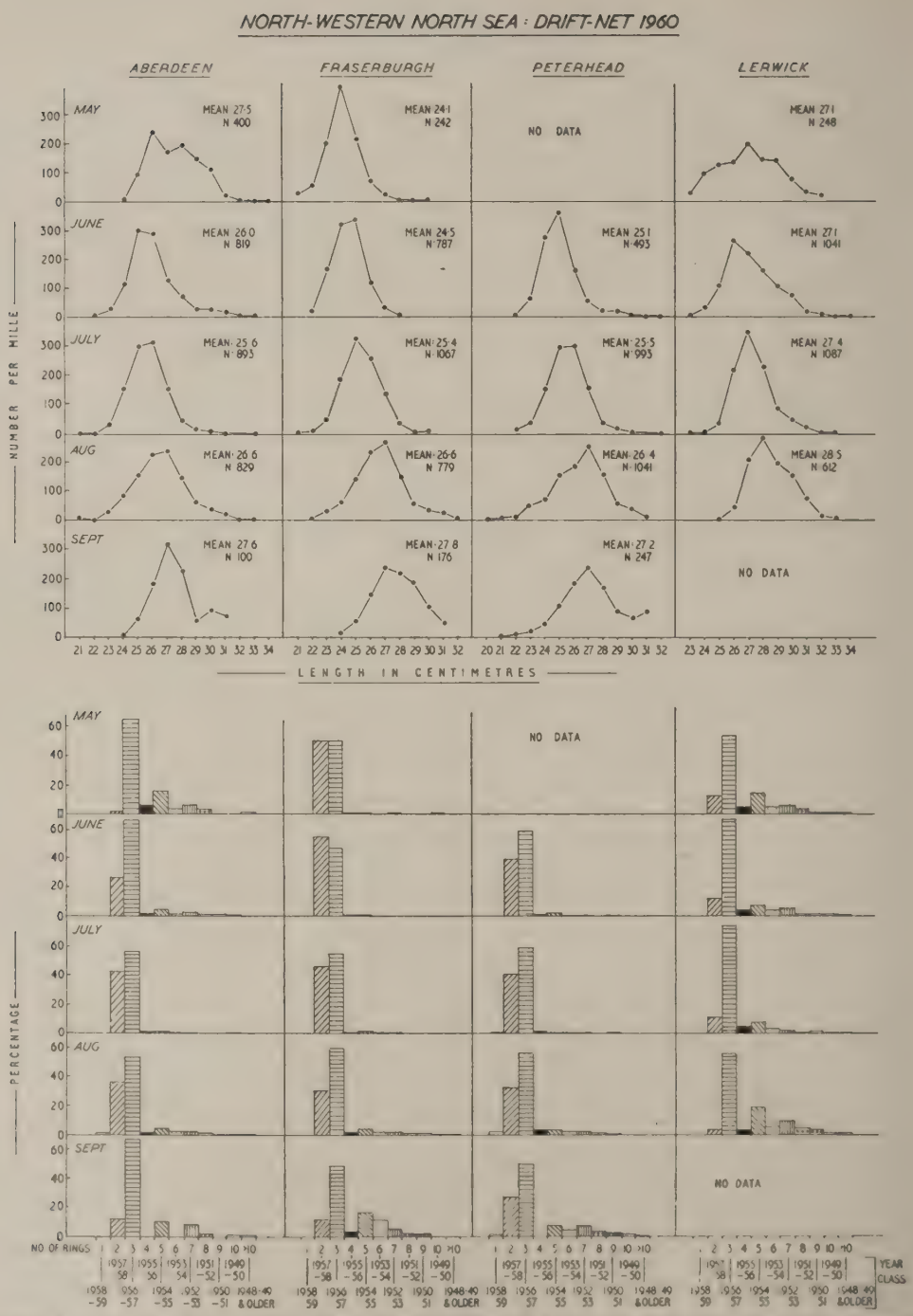


Figure 11. Length and age composition of South Minch drift-net (January/March and June) and ring-net (May and July/December) samples 1960. (Length frequencies unsmoothed.)

Table 41. West coast herring landings 1957–1960

	North Minch			South Minch		
	Landings (crans)	No. of arrivals	Landing per arrival (crans)	Landings (crans)	No. of arrivals	Landing per arrival (crans)
			Drift-Net			
1957	114,561	5,285	21.7	11,005	318	34.6
1958	172,006	7,657	22.5	15,907	415	38.3
1959	166,305	6,721	24.7	21,326	447	47.7
1960	107,616	6,141	17.5	20,170	740	27.3
			Ring-Net			
1957	20,652	881	23.4	43,466	1,563	27.8
1958	13,485	761	17.7	56,549	2,238	25.3
1959	23,908	965	24.8	70,770	2,022	35.0
1960	25,974	1,161	22.4	81,137	2,197	36.9

Table 42. Maturity and racial characters – North Minch

A. Percentage Maturity (All age-groups)

Maturity Stage	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
I	13.60	5.35	6.89	6.00	24.32	52.35	29.22	13.50	25.25	22.00	37.61	26.61
II	3.40	3.79	2.67	2.00	27.70	43.62	32.10	19.50	24.00	8.80	15.45	13.71
III	—	1.34	—	—	—	0.67	18.52	11.50	6.00	2.80	3.50	6.85
IV	1.36	3.56	0.44	—	—	1.34	16.05	21.00	8.00	0.40	6.71	6.05
V	0.68	4.45	—	—	—	0.67	1.65	23.00	3.75	—	0.29	0.81
VI	—	2.00	4.89	—	—	—	—	4.00	4.50	—	—	—
VII	—	0.22	2.22	—	0.68	—	—	2.50	14.50	31.60	0.29	0.81
VII–II	80.95	79.29	83.11	92.00	47.30	1.34	2.47	5.00	14.00	34.80	36.15	45.16
Number	147	449	450	50	148	149	243	200	400	250	343	248

B. Mean Vert. S. for each Maturity Stage

(All age-groups) (in brackets, numbers of fish)

I	56.75	56.28	56.73	56.33	56.71	56.74	56.86	56.86	56.65	56.75	56.45	56.40
	(16)	(7)	(15)	(3)	(14)	(23)	(43)	(7)	(51)	(32)	(31)	(35)
II	57.00	57.25	57.00	56.00	56.67	56.45	56.78	56.77	56.91	56.67	56.45	56.44
	(1)	(4)	(4)	(1)	(3)	(20)	(27)	(13)	(32)	(12)	(11)	(9)
III	—	57.50	—	—	—	—	56.82	56.50	56.88	56.50	57.00	57.00
		(4)					(11)	(2)	(16)	(4)	(1)	(2)
IV	—	57.50	—	—	—	57.00	56.69	56.54	56.60	57.00	56.63	56.60
		(4)				(1)	(13)	(13)	(15)	(1)	(8)	(5)
V	—	56.86	—	—	—	57.00	—	56.50	56.75	—	—	57.00
		(14)				(1)		(10)	(8)			(1)
VI	—	56.75	57.00	—	—	—	—	—	56.82	—	—	—
		(4)	(7)						(11)			
VII	—	—	56.00	—	57.00	—	—	56.50	56.50	56.50	—	57.00
			(1)		(1)			(4)	(6)	(36)		(2)
VII–II	56.63	56.58	56.56	56.33	56.75	56.50	56.50	56.00	56.40	56.63	56.53	56.48
	(79)	(161)	(167)	(46)	(32)	(2)	(4)	(1)	(10)	(64)	(45)	(44)
Overall Mean	56.67	56.62	56.59	56.33	56.74	56.62	56.80	56.62	56.72	56.62	56.51	56.47
	(96)	(198)	(194)	(50)	(50)	(47)	(98)	(50)	(149)	(150)	(96)	(98)

ring-net landings for the North and South Minch areas were the highest for the period (1957—60). The smaller drift-net landings from the North Minch were due to the winter fishery (Jan.—Mar.) being less productive, and to the restrictions imposed on the size of catches landed during the autumn fishery.

Biological Data

Length and age composition data from North and South Minch samples are given in Figures 10 and 11 and maturities and Vert. S. data are presented in Tables 42 and 43.

The North Minch data are from drift-net samples and the South Minch data are from drift-net (Jan.,

Table 43. Maturity and racial characters – South Minch

A. Percentage Maturity (All age-groups)

Maturity Stage	Jan.	Feb.	Mar.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
I	8.00	7.33	12.75	78.00	63.88	45.94	16.60	11.11	44.38	30.18	20.89
II	2.00	3.33	0.67	—	29.43	31.98	13.07	6.11	9.64	7.69	4.79
III	1.34	—	—	—	0.67	10.91	15.98	5.00	7.34	7.69	4.11
IV	0.67	3.33	—	—	0.33	6.09	27.18	10.37	3.21	2.66	1.37
V	—	0.67	—	—	—	1.52	17.22	13.15	0.20	1.78	1.71
VI	—	3.33	—	—	—	—	9.54	45.00	—	—	—
VII	–	–	–	—	—	—	0.21	7.96	19.28	9.47	7.19
VII II	88.00	82.00	86.58	22.00	5.69	3.55	0.21	1.30	15.86	40.53	59.93
Number	150	150	149	150	299	394	482	540	498	338	292

B. Mean Vert. S. for each Maturity Stage

(All age-groups) (in brackets, number of fish)

I	56.58	56.00	56.46	56.59	56.78	56.76	56.75	56.87	56.79	56.58	56.29
	(12)	(1)	(11)	(76)	(94)	(37)	(61)	(46)	(117)	(26)	(7)
II	57.00	56.80	—	—	56.66	56.59	56.71	56.86	57.07	56.75	57.50
	(3)	(5)			(41)	(34)	(45)	(28)	(15)	(8)	(2)
III	57.00	—	—	—	—	56.43	56.55	56.69	56.56	56.85	57.00
	(2)					(7)	(33)	(26)	(18)	(13)	(1)
IV	—	56.67	—	—	56.00	56.62	56.55	56.52	56.43	57.00	—
		(3)			(1)	(13)	(51)	(29)	(7)	(2)	
V	—	—	—	—	—	56.50	56.34	56.50	—	57.00	56.00
						(2)	(29)	(24)		(1)	(1)
VI	—	56.75	—	—	—	—	56.73	56.56	—	—	—
		(4)					(15)	(102)			
VII	—	—	—	—	—	—	57.00	56.45	56.63	56.38	56.50
							(1)	(22)	(32)	(13)	(4)
VII–II	56.47	56.46	56.55	56.46	56.60	57.00	—	57.00	56.60	56.54	56.68
	(129)	(85)	(88)	(24)	(10)	(1)		(5)	(55)	(35)	(34)
Overall Mean	56.49	56.49	56.54	56.56	56.73	56.65	56.62	56.63	56.71	56.60	56.63
	(146)	(98)	(99)	(100)	(146)	(94)	(235)	(282)	(244)	(98)	(49)

Table 44. Percentage of spring and autumn spawners – North Minch 1960

Period		January–March			April–June			July–September			October–December		
			%			%			%			%	
Year-class	Rings	No.	Spring	Autumn	No.	Spring	Autumn	No.	Spring	Autumn	No.	Spring	Autumn
1958–59 ...	1	-					—	10	70.00	30.00	28	82.14	17.86
1957–58 ...	2	73	90.42	9.58	150	59.33	40.67	589	46.01	53.99	499	26.65	73.35
1956–57 ...	3	373	37.53	62.47	118	22.88	77.12	155	26.45	73.55	183	17.49	82.51
1955–56 ...	4	80	5.00	95.00	30	6.67	93.33	23	8.70	91.30	35	2.86	97.14
1954–55 and older	> 4	513	1.75	98.25	49	—	100.00	68	7.35	92.65	93	2.15	97.85
Total		1,039	21.08	78.92	347	34.01	65.99	845	38.58	61.42	838	22.79	77.21

Table 45. Percentage of spring and autumn spawners – South Minch 1960

Period		January–March			May–June			July–September			October–December		
			%			%			%			%	
Year-class	Rings	No.	Spring	Autumn	No.	Spring	Autumn	No.	Spring	Autumn	No.	Spring	Autumn
1958–59 ...	1		-	—				5	100.00	—	45	64.44	35.56
1957–58 ...	2	46	76.09	23.91	321	43.61	56.38	846	31.56	68.44	703	34.14	65.86
1956–57 ...	3	112	9.82	90.18	68	14.71	85.29	265	10.19	89.81	166	19.88	80.12
1955–56	4	54	3.70	96.30	19	26.32	73.68	72	5.56	94.44	69	5.80	94.20
1954–55 and older	> 4	246	0.41	99.39	38	5.26	94.74	177	—	100.00	136	7.35	92.65
Total		448	8.71	91.29	446	35.20	64.80	1,365	22.20	77.80	1,119	28.24	71.76

Table 46. Statistics of Clyde spawning fishery 1955–1960

	1955	1956	1957	1958	1959	1960
			Ring-Net Fishery			
Number of landings	309	189	108	284	180	562
Total catch (crans)	2,394	1,183	558	302	938	10,463
Catch/landing (crans)	7.7	6.3	5.2	1.1	5.2	18.6
			Trammel-Net Fishery			
Number of landings	312	147	141	138	82	101
Total catch (crans)	1,409	401	765	641	420	704
Catch/landing (crans)	4.2	2.7	5.4	4.6	5.1	7.0

Table 47. Mean length and meristic data of 1957 brood in 1960 Clyde spawning fishery

	Mean length	Vert. S.	K_2	Pectoral fin
3-ringers Ballantrae	26.72 (727)	57.13 (382)	14.18 (428)	16.96 (446)
3-ringers S. Arran	24.86 (735)	57.12 (422)	14.22 (380)	16.83 (383)

Feb., Mar., June) and ring-net (May, July—December) catches.

The age distribution show that fish of the 1956/57 and 1954/55 year-classes were most prominent in the catches during the winter fishery (Jan.—Mar.) In the summer and autumn fisheries the catches were dominated by 2-ringed recruits of the 1957/58 year-class.

From the maturities and Vert. S. data it is evident, as in previous years, that autumn spawning herring formed the major component of the catches of older fish. This is confirmed by Tables 44 and 45 which gives the age compositions of spring and autumn spawners obtained from the analyses of otolith characters.

C. Clyde

The Fishery

The adult fishery in the Clyde Estuary is based on spawning and spent herring during the period February/April. There are two distinct localities of operation, corresponding to the two known spawning grounds; one on Ballantrae Bank, off the Ayrshire coast, and the other to the south of Arran. In the former area the fishery is predominantly pursued by anchored gill-nets; in the latter the fishery is exclusively by ring-net. As there is no basis on which to equate these two means of capture the statistics for the two fisheries are listed separately.

The catch and effort statistics of the Clyde spawning fisheries for the years 1955/60 are given in Table 46. The most striking feature of this table is the marked increase in the total catch and catch/landing in the ring-net fishery in the 1960 season. The basis of the success of the 1960 spawning fishery was the good 1957 brood which was spawning for the first time. This single brood formed 97% of the catch in both the ring-net and anchor-net fishery. The other 3% of the catches was composed of about equal proportions of fish entering on their fourth, fifth, and sixth years.

Biological Data

Only the 1957 brood was present in the samples in adequate numbers to justify the presentation of length and meristic data. These are given in

Table 48. Scottish herring tagging 1960

Liberations					Recaptures				
			Number			Lea		Scottish	
Area	Period	Lea	Scottish	Total	Area	No.	Days at Liberty	No.	Days at Liberty
Upper Moray Firth	May	289	300	589	Buchan	2	40–41	1	88
	July	72	—	72				—	
	December	70	164	234				—	
Shetland	July–August	292	665	957	Shetland	1	2	1	5
					Unknown	1			
N. Minch	November	230	—	230	N. Minch	3	5–79	—	
					S. Minch	2	26–55	—	
	December	743	—	743	N. Minch	1	Unknown	—	
					S. Minch	6	18–58		

Table 47. Although the fish at S. Arran are significantly smaller than those from Ballantrae Bank the virtual identity of the other meristic data and the correspondence in the age composition of the two populations make it unlikely that there are two distinct bodies of fish. This difference in the size for age of fish on the two spawning grounds has been a feature of this fishery in previous years and would seem to represent merely a segregation of size groups to different spawning grounds on the onset of maturation.

D. Tagging

The details of liberation and recapture of herring tagged during 1960 are given in Table 48.

B. B. Parrish, A. Saville, I. G. Baxter, G. McPherson, J. D. Buchan

Survey of the German Commercial Herring Fisheries in 1960

(Charts 1–23; Tables 49–58)

A. The Fisheries

The total landings of the German fishing fleet amounted to 185,000 tons in 1960 and are given in Table 49. The total catch decreased by 28.8% (75,000 tons). 79.5% of the total (147,000 tons) consisted of herring for human consumption and 20.5% (38,000 tons) of industrial herring. The decline in the landings is mainly due to the smaller catches of the trawlers in the North Sea and the Channel (42.4% = 67,000 tons) as well as the deep-sea cutters for factory herring (19.1% = 9,000 tons).

1. Herring trawlers

The total catch of the trawlers decreased from 131,000 to 70,000 tons (46.6%), the number of trips from 1,367 to 886 (35.2%), and the fishing days from 11,929 to 7,859 (34.1%). The decline is mainly due to the smaller catch in the North Sea (40.64% = 44,000 tons), but also from the Channel and off SE Ireland the landings decreased (20,000 tons), while those from N Ireland and N of the Hebrides increased slightly. The number of trips in the North Sea fell off from 1,082 to 819 in 1960, the fishing days from 9,467 to 8,821. The catch per day's fishing declined from 11.7 to 7.3 tons in this area.

(a) The *spring fishery* in the North Sea was centred from Viking Bank to Utsira ('Ostkante') from January to May. The total landings increased from 8,525 to 10,867 tons. 214 trips were made as compared with 218 in 1959. The catch per day's fishing rose from 4.0 to 5.0 tons. The main catch was from February to April.

(b) The *summer/autumn fishery* started in the Fladen Ground area, on 18. June and was carried out for 83 days. The main fishing was from July to the first ten days of September. In the last ten days of September, until the end of October some trawlers were fishing once more in this area. In November, only 7 landings came from this ground. 345 trips as against 607 in 1959 were made in this season. The landings decreased about 68.4% from 74,921 to 23,638 tons, the catch per day's fishing from 15.3 to 11.2 tons.

The Gut fishery was also of small importance in 1960. Only 21 trips (against 19 in 1959) were made in September and October. The total yield decreased from 1,247 to 1,202 tons. The catch per day of 9.7 tons was the same as in 1959.

On the Dogger Bank grounds, fishing started about 20. August and lasted for 52 days. The number of trips declined (14.9%) from 148 in 1959 to 126 in 1960, and the total yield from 20,783 to 13,713 tons (34.0%). The catch per day's fishing also dropped from 18.0 to 12.7 tons.

The total catch of the trawler fleet in the customary fishing areas in the North Sea in the summer/autumn fishery decreased by 60.8% from 96,951 tons in 1959 to 38,553 tons in 1960.

Table 49. Total herring landings (in 1,000 tons) of the German fishing fleet in 1960

	North Sea	Channel	SE Ireland	N Ireland	N of Hebrides	Other Areas	Total
Trawlers	65 (109)	+ (12)	+ (8)	3 (2)	1 (—)	— (+)	70 (131)
Drifters	57 (67)	4 (3)	— (+)	+ (—)	+ (—)	+ (—)	61 (70)
Fresh herring	13 (8)	+ (—)	— (—)	— (—)	— (—)	— (—)	13 (8)
Drift-net	3 (3)	— (—)	— (—)	— (—)	— (—)	— (—)	3 (3)
Trawl	10 (5)	+ (—)	— (—)	— (—)	— (—)	— (—)	10 (5)
Salt herring	44 (59)	4 (3)	— (+)	+ (—)	+ (—)	+ (—)	48 (62)
Drift-net	34 (39)	2 (1)	— (+)	+ (—)	+ (—)	+ (—)	36 (40)
Trawl	10 (20)	2 (2)	— (+)	— (—)	— (—)	— (—)	12 (22)
Deep-sea cutters	39 (45)	— (—)	— (—)	— (—)	— (—)	15 (14)	54 (59)
for consumption	2 (1)	— (—)	— (—)	— (—)	— (—)	14 (11)	16 (12)
for factories	37 (44)	— (—)	— (—)	— (—)	— (—)	1 (3)	38 (47)
Total	161 (221)	5 (15)	+ (8)	3 (2)	1 (—)	15 (14)	185 (260)

(c) In the *Channel fishery*, in November/December, 9 trips were made, compared with 131 in 1959. The total yield declined from 12,681 to 260 tons, and the catch per day's fishing from 11.0 to 9.3 tons.

Only one trip in November came from the Sandettié area, with 3 tons (58 trips and 5,383 tons in 1959). The catch per day's fishing was 1.5 against 10.1 tons. In December only a small fishery took place in the Dieppe area. Nine trips (73 in 1959) were made, and the total yield decreased from 7,298 to 257 tons, and the catch per day from 9.8 to 5.7 tons.

(d) In January 3 trips, and in November and December one trip each were made to the *Dunmore area*. The total catch in this area amounted to 56 tons (18 tons in January, 20 and 18 tons respectively in November and December) compared with 7,771 tons in 1959. The catch per day's fishing was 2.0 tons in January and 10.0 tons in November.

(e) From August to November, 43 trips were made to the *North of Ireland*. Twenty trips were made in August, 19 in October, and 2 in September and November respectively. The catch increased from 2,324 in 1959 to 4,070 tons in 1960. The main catch was in August with 2,358 tons. In September 284 tons, in October 1,265 tons, and in November 163 tons were caught. The catch per day for the whole fishing season increased from 8.6 to 10.7 tons. From August to November the catch per day dropped from 32.4 to 8.1 tons.

(f) Some fishing also took place in September and October in the area *North of the Hebrides*. Ten trips were made in this area and the catch yielded 848 tons. The catch per day amounted to 13.0 tons.

(g) Also this year, trawlers fished from October to December in the *Utsira* (*'Ostkante'*) area. The catch increased from 2,754 tons for 61 trips in 1959 to 6,125 tons in 113 trips in 1960. The average catch per day for the whole season increased from 6.0 tons in 1959 to 6.2 tons in 1960, but between October and December 1960 it declined from 9.2 to 3.4 tons.

2. Drifters

The total yield of this fishery decreased about 13.6% from 70,338 tons in 1959 to 60,760 tons in 1960. 39,140 tons (64.4%) were caught with the drift-net; 21,620 tons with the trawl (35.6%).

The catch in the North Sea amounted to 57,242 tons. 3,090 tons with the drift-net and 10,054 tons with the trawl of this quantity was caught as fresh herring, and 34,081 tons with drift-net and 10,017 tons with trawl as salted herring. From the Channel came 3,514 tons (drift-net 1,965 tons, trawl 1,549 tons) and 4 tons from other areas.

Charts 1—11 show the monthly distribution of the mean catch and the number of hauls for the drift-net fishery, and Charts 12—23 for the trawl fishery in 1960.

The *fresh herring* season in 1960 lasted the whole year for the trawl, and 8 months for the drift-net. It yielded 13,144 tons from 387 trips, against 8,086 tons from 249 trips in 1959. Increased effort was mainly responsible for the higher yield (62.6%); 23.5% of the yield was caught by drift-net and 76.5% by trawl. The fishing grounds were Ling Bank, Utsira, Bressay Shoal, Shetlands, Fladen Ground, Dogger Bank, Gut, Great Fisher Bank, 'Binnensee', and the English Channel. The main catch was made with drift-nets from April to May in the Utsira area, with the trawl from February to May also in the Utsira area, and from June to August in the Bressay/Fladen Ground area. The catch per day for the drift-net fishery was 0.6—6.3 tons (average 3.5 tons), and for the trawl 0.2—6.9 tons (average 2.8 tons).

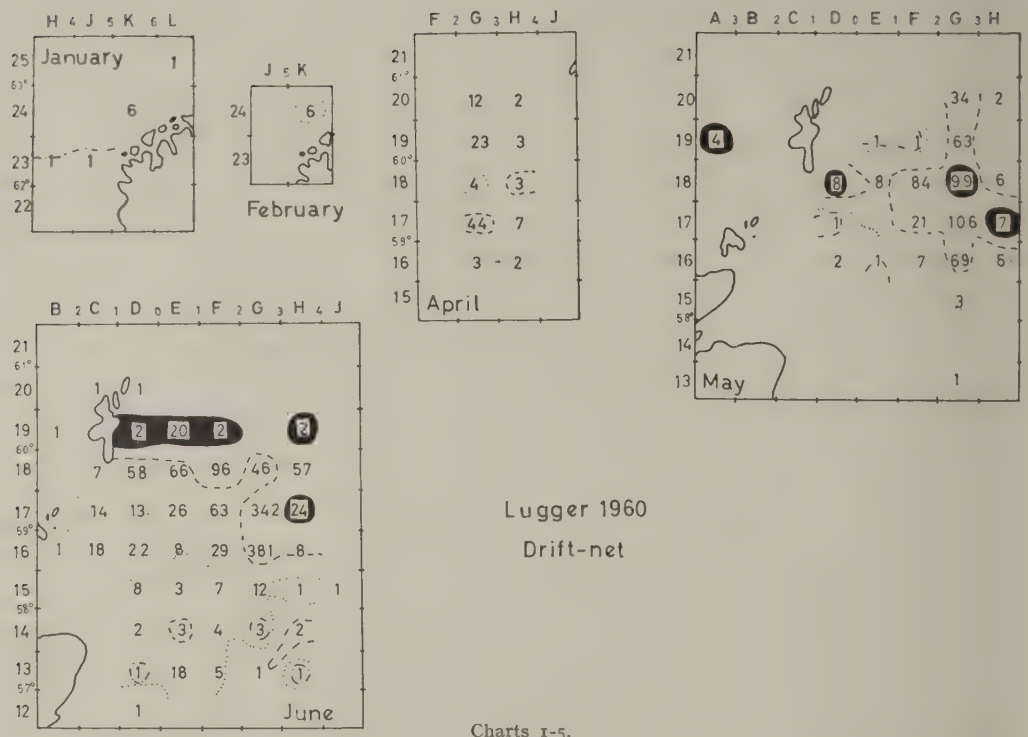
From the North Sea, 44,098 tons of *salted herring* were landed from May to December, from 479 trips, against 58,666 tons in 612 trips in 1959. The diminishing catch (24.8%) was mainly due to a decreased effort (21.7%). 77.3% were caught by drift-net and 22.7% by trawl. The catch per day decreased from 4.3 to 4.1 tons (drift-net) and from 6.4 to 5.0 tons (trawl).

In the Fladen area the catch decreased from 34,816 to 9,646 tons. 3,932 tons were taken by drift-net and 5,714 tons by trawl. Fishing by drift-net in this area took place between May and September, but the main fishing was made in June (in the northern part of the area) and July. The trawl was fished between May and October, but the main catch was taken in July and August. The catch per day showed a decrease from 4.6 to 3.3 tons (drift-net) and from 8.3 to 5.4 tons (trawl).

In the Gut, the yield dropped from 15,116 to 9,328 tons. The main catch (6,397 tons) was taken by drift-net. The main fishing took place from July to September by drift-net, and by trawl in August. The number of fishing days decreased from 2,854 to 2,130, the catch per day from 5.7 to 4.3 tons (drift-net) and from 5.7 to 4.7 tons (trawl).

In the Dogger area the yield increased from 8,256 to 13,959 tons (69.1%), and the catch per day from 3.5 to 4.4 tons (drift-net) and from 3.0 to 3.9 tons (trawl). The main fishing was carried out with drift-net (91.9%). The higher yield was the result of increased effort and better stock conditions in this area. The main fishing took place from August to October (drift-net).

Also in the Southern Bight ('Binnensee') the



Charts 1-5.

yield increased from 3,607 to 7,765 tons (115.3%). The catch per day increased from 2.1 to 4.2 tons. Increased effort and higher catch per day's fishing were responsible for the higher yield. The main fishing was in October and November.

The Channel fishery showed a small improvement, the total yield increasing from 2,794 to 3,484 tons. 1,965 tons (against 641 tons) were made by drift-net and 1,519 tons (against 2,153 tons) by trawl. The main fishing took place with the drift-net in December and with the trawl in November. The catch per day by drift-net increased from 1.3 to 2.0 tons, while the trawl increased from 4.9 to 6.4 tons.

In the North of Ireland and the Hebrides areas, some catches were made with drift-net, and yielded 4 tons.

3. Cutters

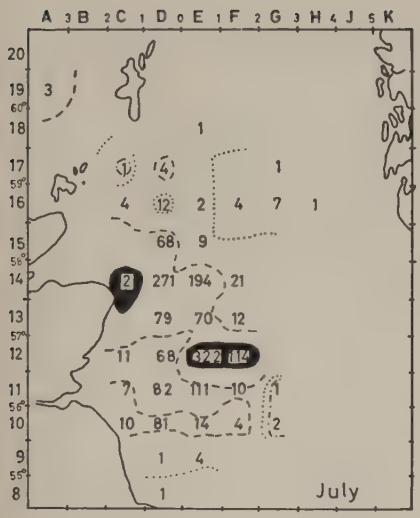
The total yield of herring for human consumption from the deep-sea and coastal cutters in the North Sea increased from 533 to 1,677 tons. The deep-sea cutters made 51 trips from August to October, as against 8 trips in 1959. The catch increased from 92 to 446 tons. The total catch of industrial herring from different types of fishery of the deep-sea cutters in the North Sea, decreased from 44,314 to 36,516 tons. The main catch came from the 'oil' herring fishery which declined from 40,755 to 22,196 tons.

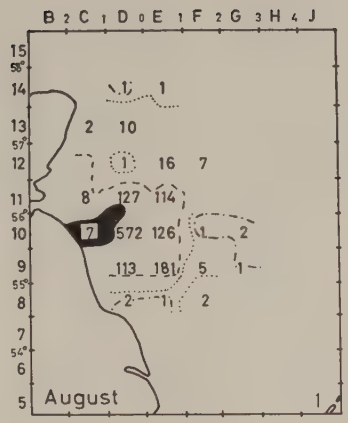
B. Biological Data

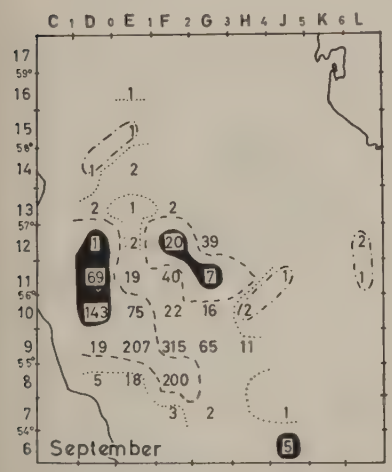
1. Viking Bank/Utsira ('Ostkante')

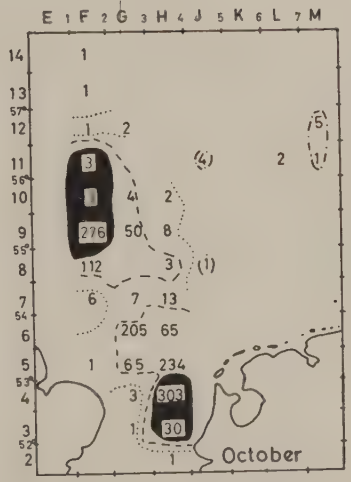
6,296 herring, caught between January and November were examined. The average length of the herring, in the samples in January, July, October, and November was between 26.38 and 26.66 cm. In February and March the average length was between 26.50 and 26.70 cm and between 31.38 and 32.57 cm, and in April, 31.65 cm (Table 50). Table 51 shows that in February the larger herring were in maturity stage V, while the smaller in stage II. In March, the larger herring were in maturity stages VII and VII/II, while the smaller fish were in stages I and II. In April, maturity stages VII and VII/II were the most frequent, whereas in July stages III, IV, and I were dominant.

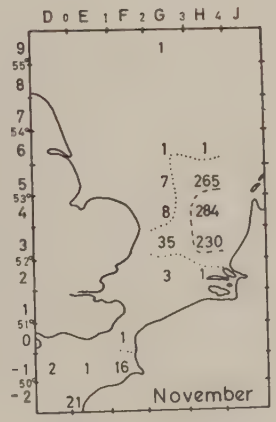
The age composition of the catches (Table 52)

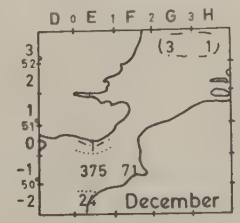












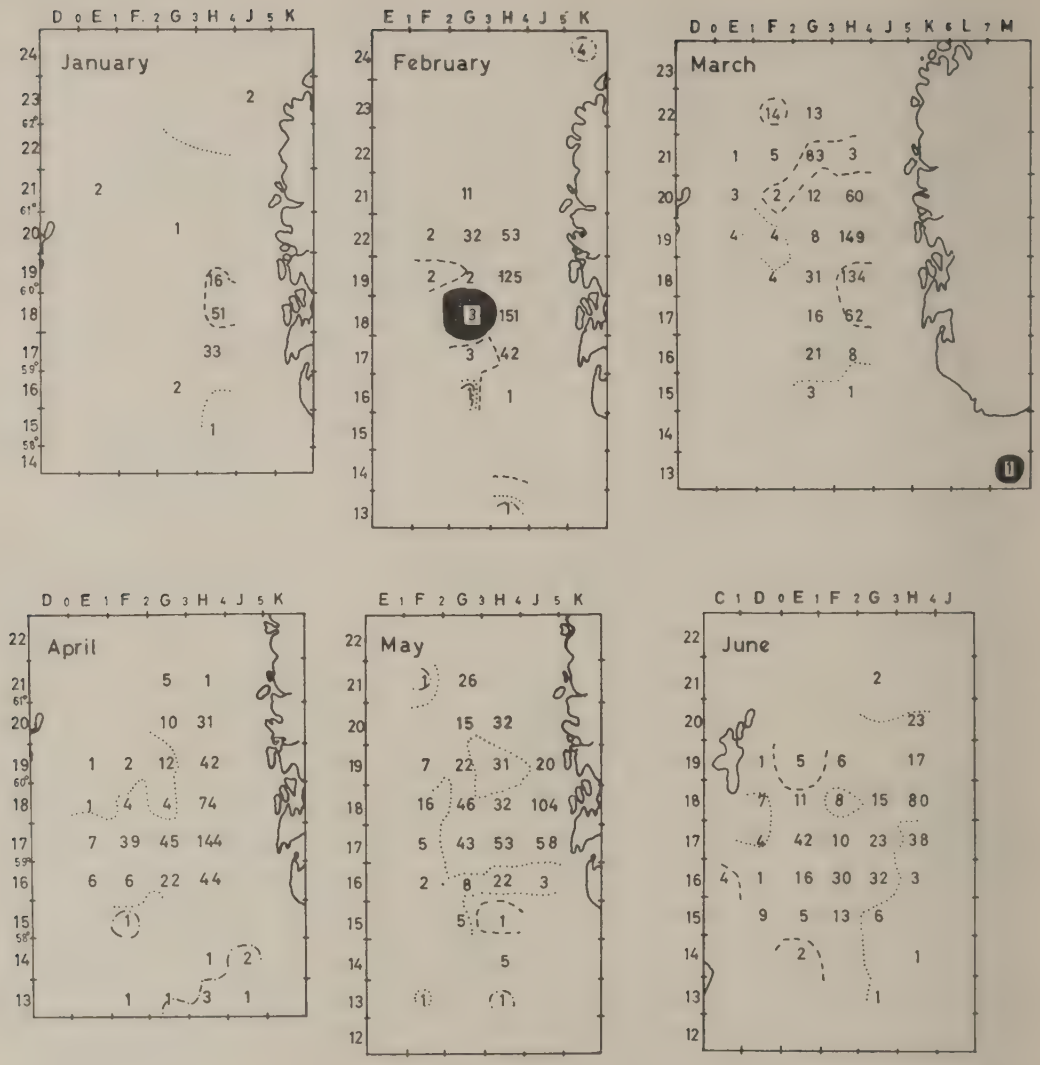
Lugger 1960

Drift-net

Charts 6-11.

Charts 1–11. German lugger herring fishery. Drift-net.
Mean catch per fishing day and number of hauls

.—.—.—. = 1—10 kantjes
..... = 11–30 kantjes
— — — — = 31–50 kantjes
———— = >50 kantjes

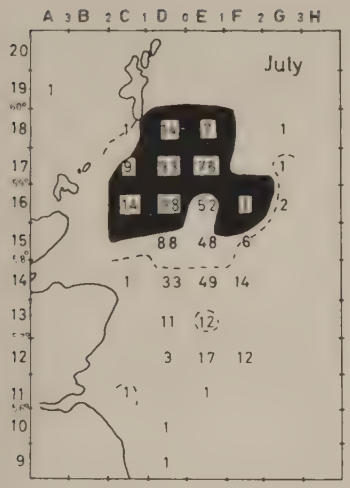


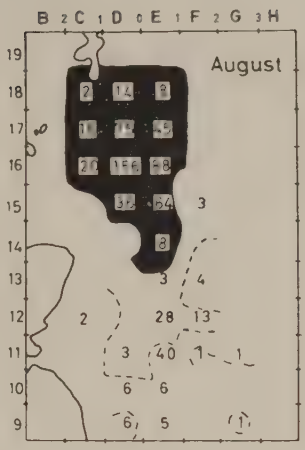
Charts 12–17.

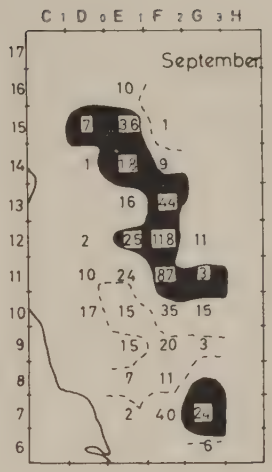
indicates that in February age-group III, VI to VIII, and older than IX were the most abundant. In March a change in the age composition occurred. Now age-groups IV, II, and IX+ formed the bulk of the catch. In April the IX+, IV, and VII groups and in July the IV and III groups were predominant.

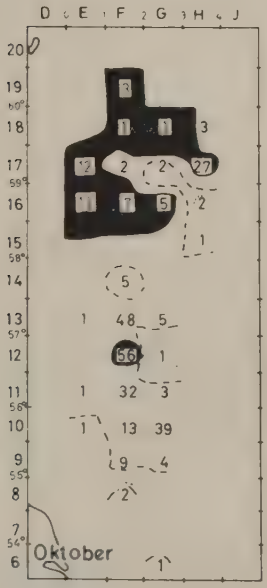
The total vertebral count data (VS) show average values of 56.71 and 57.09 from February to April and a decrease to 56.36 in July. The average number of keeled scales (K_2) were from 13.85 to 14.22 in the period January to March, and 14.48 in July. The average number of gill rakers decreased from 47.86 in January to 47.14 in March; in April, they increased to 48.61 and in July declined to 47.00 (Tables 53—55).

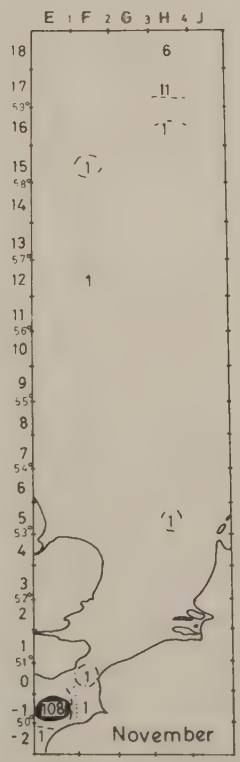
The average number of the different meristic characters in relation to maturity stages are given in Tables 56—58. These indicate that in February and March two groups of herring were present on these fishing grounds. In February, late winter spawners in stages III—VI predominated, the other

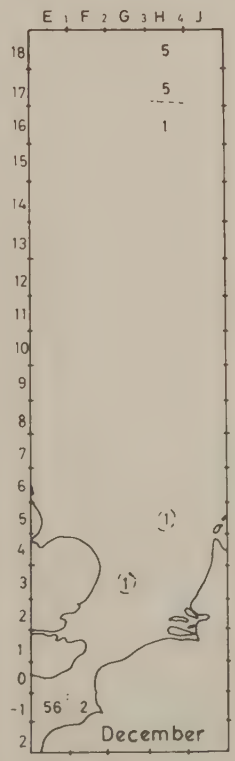












Lugger 1960

Trawl

Charts 18–23.

Charts 12–23. German lugger fishery. Trawl. Mean catch per fishing day and number of hauls.

.—.—.—. = 1–10 kantjes
..... = 11–30 kantjes
— — — — = 31–50 kantjes
———— = > 50 kantjes

Table 50. Length composition of all samples (‰)

Gear	T	T	D	T	T	T	T	T	T	T	T	T	T	T	T
Area	Viking Bank/Utsira									Bressay Shoal					
Samples	M	M	S	M	S	S	S	M	M	S	S	M	M	S	M
Month	I	II	II	III	III	IV	VII	X	XI	III	IV	VI	VII	VII	VIII
cm 38	—	—	—	8	1	—	—	—	—	—	—	—	—	—	—
37	—	—	—	47	3	8	—	—	—	—	10	—	—	—	—
36	—	—	10	119	7	25	—	—	—	—	—	—	—	—	—
35	—	—	15	134	10	37	—	—	—	—	27	—	—	—	—
34	—	—	45	**157**	16	83	—	—	1	—	10	—	—	—	—
33	2	2	121	145	32	116	5	—	—	—	32	—	—	—	—
32	26	7	202	85	60	**213**	22	—	4	3	**53**	—	1	1	1
31	52	66	**208**	45	64	204	50	6	5	31	47	—	10	13	5
30	**101**	**74**	197	28	61	37	78	28	26	54	128	6	40	71	27
29	69	61	81	51	60	87	84	61	45	57	144	11	84	83	60
28	107	66	71	77	80	124	73	124	128	74	**176**	20	155	157	104
27	113	86	35	**85**	84	54	128	140	**241**	94	160	26	278	**294**	241
26	119	118	5	15	108	12	**212**	**234**	204	208	101	91	**320**	264	**336**
25	**180**	**185**	5	4	**130**	—	101	231	164	**247**	80	271	103	68	173
24	154	163	—	—	94	—	34	113	123	139	27	**400**	9	15	41
23	40	114	5	—	54	—	28	36	32	38	—	134	—	8	12
22	35	49	—	—	22	—	50	13	16	27	5	29	—	1	—
21	—	7	—	—	14	—	17	3	8	9	—	3	—	—	—
20	—	2	—	—	10	—	28	8	3	6	—	3	—	2	—
19	2	—	—	—	11	—	46	3	—	—	—	—	—	4	—
18	—	—	—	—	6	—	39	—	—	1	—	6	—	9	—
17	—	—	—	—	2	—	—	—	—	1	—	—	—	4	—
16	—	—	—	—	5	—	5	—	—	4	—	—	—	5	—
15	—	—	—	—	16	—	—	—	—	6	—	—	—	—	—
14	—	—	—	—	27	—	—	—	—	—	—	—	—	—	—
13	—	—	—	—	18	—	—	—	—	1	—	—	—	—	—
12	—	—	—	—	4	—	—	—	—	—	—	—	—	1	—
11	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	[illegible]
9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	—	[illegible]	[illegible]	—	—	[illegible]	[illegible]	[illegible]	[illegible]
Total	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Number ..	346	407	198	470	2803	241	179	363	1289	679	188	350	581	931	907
Av. length, cm	26.66	26.50	31.38	32.57	26.70	31.65	26.38	26.48	26.66	26.33	29.02	24.96	27.44	27.37	26.98
Males ‰	—	540	419	—	436	390	352	—	—	544	295	—	—	440	—

T = Trawl, D = Drift-net, M = Market, S = Sea.

group being composed of North Sea autumn spawners in stages I, II, VII, VII/II. They were more abundant in March. The catch in April consisted of late winter spawners in stages VII, VII/II, and VI. In July the bulk of the catches was formed of North Sea autumn spawners in stages I and III—IV.

2. Ling Bank

1,448 herring from this area were investigated in March. The average length was 21.84 cm (Table 50). Maturity stage I was predominant (Table 51). The age composition (Table 52) shows the predominance of 2, 3, and 4 year-old herring. The average number of vertebrae was 56.56, of keeled scales 14.40, and of gill rakers 46.35 (Tables 53—55).

The different meristic characters in relation to maturity stages (Tables 56—58) show that the catch consisted mainly of North Sea autumn spawners. Predominant were the 2 year-old herring in stage I, followed by recovering spents in stage II, together with some stage III—IV herring. Some late winter spawners in stages V—VI were also present.

3. Bressay Shoal and Fladen Ground

From March to August, 3,636 herring from the Bressay area, and from March to September 6,274 herring from the Fladen Ground were examined. The average length in the Bressay area was between 24.96 and 29.02 cm, and on the Fladen Ground between 24.20 and 27.56 cm (Table 50). In March, maturity stages I and II were predominant in both areas, as well as stage VII/II in the Bressay area. In April, moreover, stage VI still predominated in the Bressay area. In July, stages

Table 50. Length composition (continued)

Gear	T	T	T	T	T	T	T	T	T	T	T	T
Area	Ling Bank	Fladen Ground						Gut				Dogger Bank
Samples	S	S	M	M	S	M	M	S	S	S	S	S
Month	III	III	VI	VII	VII	VIII	IX	III	VII	IX	X	VII
cm 38	—	—	—	—	—	—	—	—	—	—	—	—
37	—	—	—	—	—	—	—	—	—	—	—	—
36	—	—	—	—	—	—	—	—	—	—	—	—
35	—	—	—	—	—	—	—	—	—	—	—	—
34	1	—	—	—	—	—	—	—	—	—	—	—
33	1	—	—	—	—	—	—	—	—	—	—	—
32	4	—	—	—	1	4	—	—	—	2	—	—
31	17	6	—	1	5	18	4	19	—	19	5	—
30	32	10	8	10	18	55	21	—	—	56	34	—
29	**36**	14	13	27	37	107	62	—	4	60	40	—
28	28	13	15	59	90	168	116	—	10	75	51	2
27	21	29	70	118	**198**	239	201	—	32	219	126	7
26	28	64	162	195	188	**272**	**337**	4	123	**277**	315	20
25	58	161	**385**	**301**	109	111	174	27	**216**	184	**321**	87
24	77	**172**	237	215	41	25	66	42	156	73	103	104
23	**87**	145	82	67	35	1	17	123	94	23	5	**163**
22	79	91	18	6	49	—	2	**159**	63	9	—	97
21	85	78	8	1	83	—	—	139	58	2	—	52
20	**91**	88	—	—	99	—	—	107	**100**	1	—	51
19	48	37	2	—	37	—	—	144	85	—	—	77
18	**75**	18	—	—	5	—	—	105	48	—	—	**173**
17	69	23	—	—	4	—	—	71	8	—	—	141
16	53	37	—	—	1	—	—	33	2	—	—	26
15	**71**	13	—	—	—	—	—	33	1	—	—	—
14	34	1	—	—	—	—	—	13	—	—	—	—
13	4	—	—	—	—	—	—	—	—	—	—	—
12	1	—	—	—	—	—	—	—	—	—	—	—
11	—	—	—	—	—	—	—	—	—	—	—	—
10	—	—	—	—	—	—	—	—	—	—	—	—
9	—	—	—	—	—	—	—	—	—	—	—	—
8	—	—	—	—	—	—	—	—	—	—	—	—
Total	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Number ..	1448	1535	388	1429	1863	731	517	448	710	972	175	807
Av. length, cm	21.84	24.20	25.44	25.90	25.25	27.56	26.86	20.71	23.52	26.92	26.47	21.32
Males ‰	214	346	—	500	480	590	540	296	526	486	573	380

IV and V formed the bulk of the samples at Bressay, and on the Fladen Ground stages IV, I, and III were important. On the Fladen in August, stages V and IV were the most frequent, while in September stages VII/II, II, and VII populated this ground (Table 51).

The age composition (Table 52) shows the predominance of the strong 1956 year-class, now 4 years old, in all months and in both areas. Three year-olds were also of some importance in March and July on the Fladen and 6, 9 and older fish on the Bressay in April. In August and September 6 year-old fish also appeared.

The average number of vertebrae was 56.56/56.83 on the Bressay and 56.55/56.62 on the Fladen. The average number of keeled scales was 14.25/14.34 and 14.33/14.45 respectively and gill rakers 46.91/47.54 and 46.56/47.01 (Tables 53—55).

The meristic characters show (Tables 56—58) that in March and April on Bressay, maturity stages I, II, VII, VII/II were mainly composed of North Sea autumn spawners, whereas stages V and VI were spring spawners. In July, the stages III—IV, V—VI, II and VII belonged to the autumn group and stage I was mainly spring spawners mixed with some autumn fish. In the Fladen area in March the main part of stages I, II, VII/II were autumn spawners, while stages V and VI were spring spawners. The population in July and August consisted mainly of autumn spawners; only stages II-VII/II contained some spring spawners. In September only autumn spawners in stages V and II—VII were sampled.

4. The Gut

From March to October, 2,305 herring were investigated. In March and July smaller herring were abundant in this area, the average lengths being

Table 50. Length composition (continued)

Gear	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Area	Dogger Bank				Binnen-see	San-dettié	Chan-nel	Skagerak		Egersund		Gr. Fisher Bank			
Samples	M	S	M	S	S	S	S	S	S	S	S	S	S	S	S
Month	IX	IX	X	X	I	I	I	III	IV	III	VII	III	IV	VII	IX
cm 38 ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
37 ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
36 ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
35 ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
34 ...	—	—	—	—	—	—	—	—	—	1	20	—	—	—	—
33 ...	—	1	—	—	—	—	—	—	—	2	—	—	—	—	—
32 ...	+	9	3	—	—	—	—	—	2	15	—	—	—	—	—
31 ...	1	20	7	3	—	—	—	18	3	65	60	—	—	—	—
30 ...	11	49	43	11	—	—	—	**89**	3	**91**	**220**	—	—	—	1
29 ...	25	65	149	17	6	—	—	18	5	54	80	—	—	—	—
28 ...	41	78	152	19	9	12	45	—	1	28	40	—	—	—	9
27 ...	83	131	**193**	48	12	—	—	—	—	27	80	—	—	—	82
26 ...	145	169	149	124	33	35	—	—	6	38	20	—	—	—	**117**
25 ...	**223**	**179**	**174**	**232**	47	23	**136**	54	6	62	40	—	—	—	91
24 ...	189	102	91	212	131	35	91	**107**	7	62	20	—	—	—	24
23 ...	114	90	36	150	**328**	174	182	71	7	60	60	—	—	—	6
22 ...	99	79	3	70	204	**338**	**274**	54	12	67	20	—	10	181	4
21 ...	50	17	—	34	39	267	182	54	17	78	—	—	10	212	33
20 ...	15	2	—	14	18	93	45	54	19	**89**	—	1	40	**303**	58
19 ...	3	2	—	4	21	23	45	54	32	58	60	6	40	61	69
18 ...	1	4	—	1	—	—	—	18	92	59	100	90	**130**	**152**	160
17 ...	—	3	—	1	—	—	—	18	**124**	37	**120**	143	60	61	**234**
16 ...	—	—	—	13	—	—	—	36	102	19	60	153	90	30	85
15 ...	—	—	—	32	—	—	—	71	173	26	—	**291**	60	—	9
14 ...	—	—	—	13	3	—	—	**195**	**226**	25	—	264	10	—	9
13 ...	—	—	—	2	—	—	—	89	141	23	—	51	20	—	9
12 ...	—	—	—	—	3	—	—	—	19	13	—	1	20	—	—
11 ...	—	—	—	—	—	—	—	—	2	1	—	—	100	—	—
10 ...	—	—	—	—	24	—	—	—	1	—	—	—	—	—	—
9 ...	—	—	—	—	86	—	—	—	—	—	—	—	—	—	—
8 ...	—	—	—	—	36	—	—	—	—	—	—	—	—	—	—
Total	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Number	2395	1721	276	3976	337	86	22	56	1607	2502	50	692	100	33	668
Av. length, cm	25.09	26.19	27.20	24.27	21.42	22.50	23.14	20.38	16.42	23.48	25.00	15.87	15.25	20.40	20.89
Males ‰	—	457	—	445	—	616	500	214	154	323	420	87	190	242	404

20.71 and 23.52 cm respectively. In September and October, the average lengths were 26.92 and 26.47 cm (Table 50).

In March, maturity stages I and II were the most frequent, whereas in July, stages IV, I, and III were abundant. In September and October, stages II and VII formed the bulk of the catches (Table 51).

The 4 and 3 year-old herring were most frequent in all months. In March, September and October, the 4 year-old fish were predominant; only in July were the 3 year-olds more important (Table 52).

The average number of vertebrae was 56.39/56.40, the average number of keeled scales 14.35/14.61, and the average number of gill rakers 46.10/46.37 (Tables 53—55).

The meristic characters in relation to maturity stages show (Tables 56—58) that in March, July, September, and October herring from the North Sea autumn group populated the area.

5. Dogger Bank area

From this area, 8,175 herring were investigated in July, September, and October. The average length was between 21.32 and 27.20 cm (Table 50).

In September, maturity stages II, V, IV, and VII and in October stages II, I, and IV were predominant (Table 51).

The 4 year-olds were the predominant year-class in September and October. Next in importance were the 3 year-olds. The 2 year-olds in both months and the 5 year-olds in September were also of some importance (Table 52).

The average number of vertebrae were 56.45/56.47, the number of keeled scales 14.63/14.69, and the average number of gill rakers 45.85/46.06 (Tables 53—55).

Table 50. Length composition (continued)

Gear	T	T	T	T	T	T	T	T	T	T	T	T
Area	Jutland Bank			East of Dogger				German Bight				
Samples	S	S	S	S	S	S	S	S	S	S	S	S
Month	III	IV	IX	I	III	VII	IX	I	III	IV	VII	IX
cm 38	—	—	—	—	—	—	—	—	—	—	—	—
37	—	—	—	—	—	—	—	—	—	—	—	—
36	—	—	—	—	—	—	—	—	—	—	—	—
35	—	—	—	—	—	—	—	—	—	—	—	—
34	—	—	—	—	—	—	—	—	—	—	—	—
33	—	—	—	—	—	—	—	—	—	—	—	—
32	—	—	—	—	—	—	—	—	—	—	—	—
31	2	—	—	—	—	—	—	—	—	—	—	—
30	4	—	—	—	—	—	—	—	—	—	—	—
29	—	—	—	2	—	—	—	—	—	—	—	—
28	4	—	—	6	—	—	—	—	—	—	—	—
27	—	—	—	12	—	—	4	—	—	—	—	6
26	1	—	—	21	—	—	9	—	—	—	—	1
25	4	—	—	46	1	—	9	—	—	—	—	—
24	2	—	—	50	2	—	8	—	—	—	—	3
23	4	—	—	162	3	—	14	—	2	—	—	—
22	6	—	—	**207**	5	5	59	—	1	—	3	1
21	4	—	29	199	10	35	98	—	7	4	14	12
20	9	—	62	110	26	132	143	20	17	—	198	38
19	13	—	143	50	26	**272**	**174**	10	22	16	**230**	81
18	66	18	**404**	23	25	244	156	—	15	16	123	**203**
17	93	52	348	29	40	100	**183**	10	39	106	141	140
16	106	285	14	21	81	169	102	270	74	119	136	38
15	190	**415**	—	27	141	37	25	**280**	136	**140**	7	185
14	**231**	191	—	17	153	2	14	140	210	85	—	**227**
13	152	29	—	12	**225**	2	2	160	**256**	102	—	64
12	69	10	—	6	199	2	—	110	170	**204**	18	1
11	33	—	—	—	48	—	—	—	37	153	**90**	—
10	7	—	—	—	13	—	—	—	10	55	40	—
9	—	—	—	—	2	—	—	—	4	—	—	—
8	—	—	—	—	—	—	—	—	—	—	—	—
Total	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Number	853	383	210	482	1743	402	1902	100	2308	236	277	657
Av. length, cm	15.47	15.66	18.48	21.67	14.66	18.57	19.26	15.14	14.48	14.19	17.70	16.78
Males ‰	102	—	530	420	82	124	406	—	—	—	100	—

Autumn spawners populated the area in September and October. The main group belonged to the Bank herring, whereas stage III—IV fish in October were Downs herring (Tables 56—58).

6. SW of Egersund, Skagerak

1,663 herring from the Skagerak in March and April, and 2,502 from the Egersund area in March and July were examined. The average lengths in the Skagerak were 20.38 and 16.42 cm, and in the Egersund area, 23.48 and 25.00 cm (Table 50).

In March, maturity stages I and II, and in April, stage I formed the bulk of the catch in the Skagerak. In the Egersund area in March stages I, VII/II, and II and in July stages I, IV, and II were important (Table 51).

The age composition in the Skagerak showed the predominance of 2, 3, and 4 year-old herring in March, while in April only the 2 year-old fish were predominant. In the Egersund area in March the most abundant year-classes were the 3, 2, 4, and over 9 year-old herring. The sequence of the year-classes in July were 2, over 9, 3, 4, and 8 year-old fish (Table 52).

The average numbers of vertebrae were 56.53 and 56.69 in the Skagerak, the number of keeled scales 14.63 and 14.29, and the number of gill rakers 46.18 and 46.64. In the Egersund area these data in March and July were: vertebrae 56.52 and 56.84, keeled scales 14.48 and 14.36, and gill rakers 46.41 and 46.71 (Tables 53—55).

In March/April, the fish in maturity stage I in the Skagerak, formed a mixture of North Sea autumn spawners and spring spawners; stages II—VII/II were North Sea autumn spawners and stages III—VI spring spawners. In the Egersund area a similar composition was found in March,

Table 51. Sexual maturity in all samples (‰)

Area	Viking Bank/Utsira				Ling Bank	Bressay Shoal			Fladen Ground			
Month	II	III	IV	VII	III	III	IV	VII	III	VII	VIII	IX
Stages I	17	245	—	339	735	217	32	35	496	288	110	—
II	158	323	65	16	110	576	223	15	438	24	70	140
III	7	2	—	177	4	2	5	15	—	252	50	—
IV	60	—	—	468	3	2	11	835	2	430	340	—
V	648	3	—	—	1	—	26	100	2	4	410	90
VI	—	28	73	—	3	4	373	—	2	—	—	—
VII	53	120	480	—	15	13	101	—	16	—	—	100
VII/II	57	279	382	—	129	186	229	—	44	2	20	670
Total	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Number	298	1329	123	62	791	474	188	200	500	458	100	100

Area	Gut				Dogger Bank		Binnen-see	San-dettié	Chan-nel	Skagerak		Egersund	
Month	III	VII	IX	X	IX	X	I	I	I	III	IV	III	VII
Stages I	753	345	31	—	94	227	387	—	—	680	919	562	480
II	209	5	780	612	294	352	446	—	—	178	14	162	100
III	—	175	20	6	39	62	—	—	—	—	11	5	80
IV	—	475	27	6	185	201	—	—	—	18	9	12	320
V	—	—	18	—	190	67	—	—	—	—	2	8	20
VI	—	—	2	6	39	7	—	942	727	18	2	10	—
VII	—	—	122	370	159	84	—	35	46	53	7	8	—
VII/II	38	—	—	—	—	—	167	23	227	53	36	233	—
Total	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Number	239	200	490	157	690	1799	150	86	22	56	553	774	50

Area	Gr. Fisher Bank			Jutland Bank			East of Dogger				German Bight				
Month	III	IV	IX	III	IV	IX	I	III	VII	IX	I	III	IV	VII	IX
Stages I	1000	1000	381	822	1000	1000	600	992	1000	920	1000	997	1000	1000	934
II	—	—	—	10	—	—	280	8	—	2	—	—	—	—	3
III	—	—	—	7	—	—	—	—	—	30	—	3	—	—	11
IV	—	—	74	7	—	—	—	—	—	23	—	—	—	—	20
V	—	—	118	10	—	—	—	—	—	18	—	—	—	—	17
VI	—	—	412	10	—	—	20	—	—	5	—	—	—	—	6
VII	—	—	15	37	—	—	—	—	—	2	—	—	—	—	9
VII/II	—	—	—	97	—	—	100	—	—	—	—	—	—	—	—
Total	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Number	300	100	136	299	100	100	100	378	97	636	100	400	100	100	349

whereas in July, stage I fish were mixed spring and autumn spawners, stage II spring spawners, stage III—IV a mixture, and stage V—VI autumn spawners (Tables 56—58).

7. Great Fisher Bank, Jutland Bank

1,493 herring from the Great Fisher Bank in March/September, and 1,765 herring from the Jutland Bank in the same period were examined. Both areas were mainly populated by smaller herring, the average length increasing between March/April to September from 15.25 to 20.89 cm on the Great Fisher Bank, and from 15.47 to 18.48 cm on the Jutland Bank. Only in September were larger fish found on the Great Fisher Bank, whereas in the Jutland Bank area only in March were larger fish met with (Tabel 50).

In March and April, maturity stage I was predominant in the Fisher Bank area, whereas in September stages VI, I, and V were the most abundant. In the Jutland Bank area stage I was predominant in all months, although in March, stages VII to VII/II were also of some importance (Table 51).

Table 52 shows that on the Great Fisher Bank in March and April and on the Jutland Bank in March, April, and September 2 year-old herring were the predominant year-class, whereas in September on the Great Fisher Bank 4 year-old fish

Table 52. Age composition of all samples (‰)

Area		Viking Bank/Utsira				Ling Bank	Bressay Shoal			Fladen Ground			
Month		II	III	IV	VII	III	III	IV	VII	III	VII	VIII	IX
Year-class	Age												
1959	1	—	—	—	—	—	—	—	—	—	—	—	—
58	2	4	**132**	—	65	**399**	4	—	—	67	160	—	—
57	3	**158**	70	—	**371**	274	89	16	40	305	212	60	140
56	4	56	**427**	**233**	**468**	187	**640**	**484**	**643**	**532**	**499**	**490**	**620**
55	5	63	23	34	48	11	47	90	61	42	39	50	30
54	6	102	70	51	—	30	72	**133**	81	18	28	**150**	**120**
53	7	**133**	40	**112**	—	19	32	64	55	6	24	60	40
52	8	116	82	78	32	41	51	69	95	8	22	90	40
51	9	95	34	78	16	9	12	43	15	6	7	10	10
<51	>9	273	122	414	—	30	53	110	10	16	9	90	—
Total ...		1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Number .		285	1310	116	62	788	472	188	199	495	457	100	100

Area		Gut				Dogger Bank		Binnen-see	San-dettié	Chan-nel	Skagerak		Egersund	
Month		III	VII	IX	X	IX	X	I	I	I	III	IV	III	VII
Year-class	Age													
1959	1	—	—	—	—	—	55	—	—	—	—	—	—	—
58	2	137	145	16	—	101	140	**333**	—	—	**455**	**830**	247	**368**
57	3	392	**490**	193	237	240	343	47	116	95	200	79	**277**	102
56	4	**467**	335	**550**	**635**	**388**	**368**	**506**	**790**	**714**	218	50	181	102
55	5	4	15	20	6	114	32	67	47	—	18	—	17	20
54	6	—	10	70	45	33	16	40	35	48	—	9	30	41
53	7	—	5	53	32	32	11	7	12	95	18	4	19	20
52	8	—	—	53	32	41	17	—	—	—	55	7	60	**102**
51	9	—	—	16	—	12	9	—	—	48	36	21	26	20
<51	>9	—	—	29	13	39	9	—	—	—	—	—	**143**	225
Total ...		1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Number .		240	200	488	156	691	1798	150	86	21	55	536	769	49

Area		Gr. Fisher Bank			Jutland Bank			East of Dogger				German Bight				
Month		III	IV	IX	III	IV	IX	I	III	VII	IX	I	III	IV	VII	IX
Year-class	Age															
1959	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	**545**
58	2	**987**	**908**	—	**759**	**990**	**1000**	60	**820**	**1000**	**928**	**960**	**932**	**980**	**979**	395
57	3	13	82	95	93	10	—	**470**	150	—	38	40	68	20	21	20
56	4	—	10	**881**	61	—	—	420	19	—	32	—	—	—	—	40
55	5	—	—	12	11	—	—	40	11	—	2	—	—	—	—	—
54	6	—	—	—	7	—	—	10	—	—	—	—	—	—	—	—
53	7	—	—	—	4	—	—	—	—	—	—	—	—	—	—	
52	8	—	—	12	2	—	—	—	—	—	—	—	—	—	—	—
51	9	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—
<51	>9	—	—	—	61	—	—	—	—	—	—	—	—	—	—	—
Total ...		1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Number .		299	98	84	459	100	100	100	377	97	599	100	400	99	98	347

was the important year-class. In March the over 9 year-old herring were of some importance on the Jutland Bank.

The total number of meristic characters show a decline in the average number of vertebrae on the Great Fisher Bank from March to September from 56.82 to 56.49 and also on the Jutland Bank from 56.69 to 56.48. On the other hand, the average number of keeled scales increased in the different months. The average number of gill rakers was 46.05 in September on the Great Fisher Bank and 46.21 in March and 45.14 in September on the Jutland Bank (Tables 53—55).

Table 53. Total number of vertebrae (VS) (‰)

Area	Viking Bank/Utsira				Ling Bank	Bressay Shoal			Fladen Ground				Gut	
Month	II	III	IV	VII	III	III	IV	VII	III	VII	VIII	IX	III	VII
VS 59	—	6	8	—	4	—	11	—	—	—	—	—	—	—
58	166	102	221	32	73	47	156	65	68	51	50	20	77	62
57	527	522	623	355	458	491	511	513	461	482	570	535	427	454
56	300	342	148	565	421	436	301	392	436	436	330	425	466	443
55	7	26	—	32	39	26	16	30	31	29	50	20	30	41
54	—	1	—	16	4	—	5	—	2	2	—	—	—	—
53	—	1	—	—	1	—	—	—	2	—	—	—	—	—
Total	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Number ...	296	1320	122	62	770	464	186	199	488	452	100	99	232	194
Average VS	56.85	56.71	57.09	56.36	56.56	56.56	56.83	56.61	56.56	56.55	56.62	56.56	56.55	56.54

Area	Gut		Dogger Bank		Binnen-see	San-dettié	Chan-nel	Skagerak		Egersund		Gr. Fisher Bank		
Month	IX	X	IX	X	I	I	I	III	IV	III	VII	III	IV	IX
VS 59	—	—	—	—	—	—	—	—	7	1	20	10	10	8
58	—	39	50	42	61	23	45	94	125	78	225	146	70	16
57	486	414	439	446	510	628	500	434	472	426	367	544	400	457
56	452	468	449	443	395	314	410	396	346	435	347	255	500	496
55	33	66	59	60	34	35	45	57	48	59	41	45	20	23
54	29	13	3	9	—	—	—	19	2	1	—	—	—	—
53	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Number ...	484	152	675	1764	147	86	22	53	545	763	49	294	100	127
Average VS	56.39	56.40	56.47	56.45	56.60	56.64	56.55	56.53	56.69	56.52	56.84	56.82	56.55	56.49

Area	Jutland Bank			East of Dogger				German Bight				
Month	III	IV	IX	I	III	VII	IX	I	III	IV	VII	IX
VS 59	2	—	—	—	—	—	2	—	3	—	—	3
58	132	10	60	85	52	74	53	40	61	30	20	47
57	464	398	445	382	474	505	453	540	500	570	459	473
56	363	500	425	469	422	379	447	400	400	360	459	427
55	35	92	60	53	52	42	42	20	33	40	62	47
54	4	—	10	11	—	—	3	—	3	—	—	3
53	—	—	—	—	—	—	—	—	—	—	—	—
Total	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Number ...	432	98	99	94	367	95	622	100	392	100	98	337
Average VS	56.69	56.33	56.48	56.48	56.53	56.61	56.52	56.60	56.59	56.59	56.44	56.52

Table 54. Total number of keeled scales (K_2) (‰)

Area	Viking Bank/Utsira				Ling Bank	Bressay Shoal			Fladen Ground				Gut	
Month	II	III	IV	VII	III	III	IV	VII	III	VII	VIII	IX	III	VII
K_2 19	—	—	—	—	—	—	—	—	—	—	—	—	—	—
18	—	2	—	17	5	—	—	—	—	5	—	—	—	—
17	4	6	—	—	10	9	—	6	11	7	24	—	6	5
16	23	35	8	138	66	58	56	56	75	60	49	74	112	136
15	249	304	142	310	326	340	266	338	380	325	366	337	339	404
14	509	485	542	398	477	454	497	444	422	456	463	494	458	382
13	211	160	308	103	106	135	181	150	108	142	98	95	85	63
12	4	8	—	34	5	4	—	6	4	5	—	—	—	10
Total	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Number ...	265	1248	120	58	577	450	177	180	455	434	82	95	177	191
Average K_2	14.08	14.22	13.85	14.48	14.40	14.34	14.25	14.31	14.45	14.33	14.44	14.39	14.50	14.61

Table 54 (continued)

Area	Gut		Dogger Bank		Binnen-see	San-dettié	Chan-nel	Skagerak		Egersund		Gr. Fisher Bank		
Month	IX	X	IX	X	I	I	I	III	IV	III	VII	III	IV	IX
K_2 19	—	—	—	—	—	—	—	20	—	—	—	5	—	8
18	—	—	2	2	6	—	—	—	—	2	23	—	21	—
17	20	—	21	17	14	—	—	20	12	14	23	—	21	23
16	55	64	129	130	112	155	95	98	72	86	45	71	85	95
15	388	347	424	392	546	464	476	353	246	380	273	249	511	493
14	435	469	367	375	280	321	381	431	538	402	477	543	330	333
13	98	113	51	82	42	60	48	78	127	113	159	132	32	48
12	4	7	6	2	—	—	—	—	5	3	—	—	—	—
Total	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Number ...	451	141	665	1727	143	84	21	51	418	652	44	197	94	126
Average K_2	14.45	14.35	14.69	14.63	14.84	14.71	14.62	14.63	14.29	14.48	14.36	14.28	14.80	14.75

Area	Jutland Bank			East of Dogger				German Bight				
Month	III	IV	IX	I	III	VII	IX	I	III	IV	VII	IX
K_2 19	—	—	—	—	—	—	2	11	—	-	—	—
18	—	—	—	—	6	—	3	—	2	10	30	—
17	3	34	42	11	22	—	25	11	23	10	14	10
16	59	80	95	118	137	87	167	186	141	71	104	135
15	293	545	484	344	475	420	461	514	485	525	449	418
14	481	273	379	419	304	435	312	247	323	364	389	358
13	161	68	—	97	50	58	30	31	26	10	14	72
12	3	—	—	11	6	—	—	—	—	10	—	7
Total	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Number ...	341	88	95	93	358	69	605	97	390	99	67	288
Average K_2	14.25	14.74	14.80	14.49	14.78	14.54	14.86	14.94	14.82	14.71	14.81	14.63

In March on the Great Fisher Bank and on the Jutland Bank, maturity stage I consisted of a mixture of spring and autumn spawners. The stages II to VII/II on the Jutland Bank were autumn spawners and stages V—VI were spring spawners. In April and September on both grounds, autumn spawners from the North Sea were found, presumably stages III—IV belonging to the southerly autumn stock (Tables 56—58).

8. East of Dogger

From this area, 2,627 herring were investigated in January, March, July, and September. In January the average length was 21.67 cm, in March 14.66 cm, in July 18.57 cm, and in September 19.26 cm (Table 50). In January, maturity stage I formed the bulk of the catch, but stages II and VII/II were also of some importance. From March to September stage I was predominant, but some fish in stages II to VII were also present in the area (Table 51).

In January the 3 and 4 year-old fish were abundant, whereas in March, July, and September 2 year-olds were predominant (Table 52).

The average number of the meristic characters in the four months were: vertebrae 56.48 to 56.61, keeled scales 14.49 to 14.86, and gill rakers 45.06 to 45.77 (Tables 53-55).

The stock was composed, presumably, by a mixture of the different autumn spawning groups, but in all months the Bank group was predominant (Tables 56—58).

9. German Bight

From January to September, 3,578 herring were examined. The average length was, in January 15.14 cm, in March 14.48 cm, in April 14.19 cm, in July 17.70, and in September 16.78 cm (Table 50).

In all months maturity stage I was predominant (Table 51). From January to July the 2 year-olds were the most important year-class, but in September the 1 year-old fish became predominant (Table 52). The meristic characters showed the following averages: vertebrae 56.44 to 56.60, keeled scales 14.63 to 14.94, and gill rakes 45.04 to 46.00 (Tables 53—55). The stock from January to April appeared to be composed largely of the Downs group, whereas from July the Bank group was predominant (Tables 56—58).

Table 55. Total number of gill rakers (Rf) (‰)

Area	Viking Bank/Utsira				Ling Bank	Bressay Shoal			Fladen Ground				Gut	
Month	II	III	IV	VII	III	III	IV	VII	III	VII	VIII	IX	III	VII
Rf 53	3	1	24	—	—	2	5	—	—	—	11	—	–	
52	3	7	33	—	3	—	5	—	—	—	11	—	5	—
51	34	25	57	—	3	7	21	10	10	5	21	—	—	
50	112	57	171	88	18	38	53	31	25	25	21	32	9	5
49	214	121	220	59	66	105	202	98	66	83	84	97	36	15
48	238	205	195	206	161	205	267	253	139	153	211	269	155	126
47	193	229	235	265	200	243	181	227	274	269	231	172	218	278
46	122	175	57	235	245	235	160	186	239	203	221	258	232	263
45	54	118	8	88	176	88	59	149	144	160	158	107	182	172
44	24	47	—	59	98	60	37	26	78	86	31	54	113	101
43	3	5	—	—	18	15	5	15	15	11	—	11	45	40
42	—	1	—	—	12	2	5	5	10	5	—	—	5	–
41	—	1	—	—	—	—	—	—	—	—	—	—	—	—
Total	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Number ...	295	1094	123	34	335	400	188	194	395	443	95	93	220	198
Average Rf .	47.86	47.14	48.61	47.00	46.35	46.91	47.54	46.93	46.56	46.56	47.01	46.88	46.14	46.10

Area	Gut		Dogger Bank		Binnen-see	San-dettié	Chan-nel	Skagerak		Egersund		Gr. Fisher Bank
Month	IX	X	IX	X	I	I	I	III	IV	III	VII	IX
Rf 53	—	—	—	—	—	—	—	—	—	—	—	–
52	—	—	—	—	—	—	—	—	—	2	—	-
51	6	—	4	2	—	—	—	—	—	11	24	–
50	15	19	10	9	—	—	—	—	38	31	—	—
49	61	58	43	30	10	—	—	61	125	62	98	37
48	159	128	107	112	71	82	136	91	113	142	120	138
47	219	264	219	197	253	106	45	273	274	210	220	237
46	255	269	263	245	212	235	274	242	162	239	170	213
45	183	141	216	195	222	294	91	212	200	185	195	213
44	83	115	91	141	162	235	364	121	75	95	49	125
43	15	—	30	52	40	24	45	—	13	16	24	37
42	2	6	16	17	20	24	55	—	—	4	—	–
41	2	—	1	—	10	—	—	—	—	3	—	-
Total	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Number ...	471	156	668	1692	99	85	22	33	80	640	41	80
Average Rf	46.40	46.37	46.06	45.85	45.63	45.34	45.18	46.18	46.64	46.41	46.71	46.05

Area	Jutland Bank		East of Dogger				German Bight	
Month	III	IX	I	III	VII	IX	VII	IX
Rf 53	—	—	—	—	—	—	—	—
52	—	—	—	—	—	—	—	—
51	21	—	—	—	—	—	—	—
50	11	—	11	43	14	5	—	—
49	95	17	34	—	14	15	—	—
48	74	51	80	43	27	45	57	136
47	211	119	216	43	95	180	86	183
46	199	203	273	305	202	251	243	455
45	231	237	159	174	350	270	214	45
44	126	237	102	305	122	150	286	136
43	32	119	114	87	135	58	86	45
42	—	17	11	—	14	23	28	—
41	-	—	—		27	3		-
Total	1000	1000	1000	1000	1000	1000	1000	1000
Number	95	59	88	23	74	399	70	22
Average Rf	46.21	45.14	45.77	45.26	45.06	45.49	45.04	46.00

Table 56. Total number of vertebrae (VS) in relation to stages of maturity

Area	Viking Bank/Utsira								Ling Bank		Bressay Shoal			
Month	II		III		IV		VII		III		III + IV		VII	
Stages of maturity	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.
I	5	56.40	324	56.79	—	—	21	56.47	564	56.61	108	56.61	7	56.86
II + VII + VII/II	80	56.45	952	56.67	113	57.08	1	57.00	199	56.45	461	56.57	3	56.67
III + IV	19	57.00	3	56.33	—	—	40	56.28	4	56.25	—	—	169	56.61
V + VI	192	57.02	41	57.07	9	57.22	—	—	3	56.67	81	57.07	20	56.55
Total/Mean	296	56.85	1320	56.71	122	57.09	62	56.36	770	56.56	650	56.64	199	56.61

Area	Fladen Ground						Gut					
Month	III		VII + VIII		IX		III		VII		IX + X	
Stages of maturity	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.
I	243	56.61	141	56.65	—	—	174	56.56	69	56.67	15	56.60
II + VII + VII/II	242	56.50	21	56.62	91	56.54	58	56.52	—	—	585	56.47
III + IV	—	—	347	56.52	—	—	—	—	125	56.46	25	56.68
V + VI	3	56.67	43	56.58	8	56.75	—	—	—	—	11	56.82
Total/Mean	488	56.56	552	56.56	99	56.56	232	56.55	194	56.54	636	56.40

Area	Dogger Bank				Binnensee		Sandettié		Channel		Skagerak	
Month	IX		X		I		I		I		III + IV	
Stages of maturity	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.
I	62	56.50	401	56.38	57	56.72	—	—	—	—	537	56.70
II + VII + VII/II	304	56.47	771	56.41	90	56.52	5	56.40	6	56.57	46	56.46
III + IV	151	56.44	461	56.57	—	—	—	—	—	—	12	56.58
V + VI	158	56.51	131	56.52	—	—	81	56.65	16	56.50	3	56.00
Total/Mean	675	56.47	1764	56.45	147	56.60	86	56.64	22	56.55	598	56.68

Area	Egersund				Gr. Fisher Bank					
Month	III		VII		III		IV		IX	
Stages of maturity	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.
I	427	56.60	23	56.83	294	56.82	100	56.55	51	56.61
II + VII + VII/II	309	56.39	5	57.20	—	—	—	—	—	—
III + IV	14	56.71	20	56.80	—	—	—	—	9	56.89
V + VI	13	57.00	1	56.00	—	—	—	—	67	56.34
Total/Mean	763	56.52	49	56.84	294	56.82	100	56.55	127	56.49

Area	Jutland Bank						East of Dogger							
Month	III		IV		IX		I		III		VII		IX	
Stages of maturity	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.
I	381	56.58	98	56.33	99	56.48	57	56.58	367	56.53	95	56.61	573	56.51
II + VII + VII/II	41	56.44	—	—	—	—	37	56.32	—	—	—	—	2	57.00
III + IV	4	55.50	—	—	—	—	—	—	—	—	—	—	32	56.63
V + VI	6	57.17	—	—	—	—	—	—	—	—	—	—	15	56.47
Total/Mean	432	56.69	98	56.33	99	56.48	94	56.48	367	56.53	95	56.61	622	56.52

Area	German Bight									
Month	I		III		IV		VII		IX	
Stages of maturity	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.
I	100	56.60	392	56.59	100	56.59	98	56.44	315	56.51
II + VII + VII/II	—	—	—	—	—	—	—	—	4	56.25
III + IV	—	—	—	—	—	—	—	—	10	56.80
V + VI	—	—	—	—	—	—	—	—	8	56.63
Total/Mean	100	56.60	392	56.59	100	56.59	98	56.44	337	56.52

Table 57. Total number of keeled scales (K_2) in relation to stages of maturity

Area	Viking Bank/Utsira								Ling Bank		Bressay Shoal			
Month	II		III		IV		VII		III		III + IV		VII	
Stages of maturity	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.
I	5	14.60	273	14.23	—	—	18	14.33	380	14.36	106	14.35	7	14.57
II + VII + VII/II	73	14.40	932	14.23	111	13.85	1	13.00	191	14.47	445	14.33	3	14.33
III + IV	15	13.87	3	13.67	—	—	39	14.59	3	15.00	—	—	150	14.30
V + VI	172	13.96	40	13.95	9	13.89	—	—	3	14.33	76	14.04	20	14.25
Total Mean	265	14.08	1248	14.22	120	13.85	58	14.48	577	14.40	627	14.31	180	14.31

Area	Fladen Ground						Gut					
Month	III		VII + VIII		IX		III		VII		IX + X	
Stages of maturity	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.
I	218	14.44	130	14.30	—	—	123	14.54	68	14.68	10	14.20
II + VII + VII/II	234	14.45	18	14.33	86	14.37	54	14.41	—	—	552	14.41
III + IV	—	—	332	14.35	—	—	—	—	123	14.57	21	14.67
V + VI	3	14.33	36	14.50	9	14.56	—	—	—	—	9	15.22
Total Mean	455	14.45	516	14.35	95	14.39	177	14.50	191	14.61	592	14.43

Area	Dogger Bank				Binnensee		Sandettié		Channel		Skagerak	
Month	IX		X		I		I		I		III + IV	
Stages of maturity	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.
I	62	14.74	393	14.41	57	14.86	—	—	—	—	413	14.30
II + VII + VII/II	302	14.55	749	14.52	86	14.76	5	14.40	6	14.67	42	14.62
III + IV	149	14.76	461	14.89	—	—	—	—	—	—	11	14.36
V + VI	152	14.88	124	14.95	—	—	79	14.73	15	14.60	3	14.00
Total/Mean	665	14.69	1727	14.63	143	14.84	84	14.71	21	14.62	469	14.33

Area	Egersund				Gr. Fisher Bank					
Month	III		VII		III		IV		IX	
Stages of maturity	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.
I	332	14.43	18	14.33	197	14.28	94	14.80	48	15.00
II + VII + VII/II	295	14.55	5	14.20	—	—	—	—	—	—
III + IV	12	14.25	20	14.45	—	—	—	—	9	14.67
V + VI	13	14.46	1	14.00	—	—	—	—	69	14.58
Total/Mean	652	14.48	44	14.36	197	14.28	94	14.80	126	14.75

Area	Jutland Bank						East of Dogger							
Month	III		IV		IX		I		III		VII		IX	
Stages of maturity	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.
I	291	14.24	88	14.74	95	14.80	57	14.58	358	14.78	69	14.54	557	14.86
II + VII + VII/II	41	14.32	—	—	—	—	36	14.36	—	—	—	—	2	15.50
III + IV	4	14.25	—	—	—	—	—	—	—	—	—	—	32	14.97
V + VI	5	14.20	—	—	—	—	—	—	—	—	—	—	14	14.57
Total Mean	341	14.25	88	14.74	95	14.80	93	14.49	358	14.78	69	14.54	605	14.86

Area	German Bight									
Month	I		III		IV		VII		IX	
Stages of maturity	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.
I	97	14.94	390	14.82	99	14.71	67	14.81	265	14.64
II + VII + VII/II	—	—	—	—	—	—	—	—	4	14.75
III + IV	—	—	—	—	—	—	—	—	11	14.64
V + VI	—	—	—	—	—	—	—	—	8	14.38
Total Mean	97	14.94	390	14.82	99	14.71	67	14.81	288	14.63

Table 58. Total number of gill rakers (Rf) in relation to stages of maturity

Area	Viking Bank/Utsira								Ling Bank		Bressay Shoal			
Month	II		III		IV		VII		III		III + IV		VII	
Stages of maturity	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.
I	5	47.00	148	46.32	—	—	7	47.57	130	45.87	96	46.69	7	48.71
II + VII + VII/II	77	46.77	908	47.22	114	48.68	1	50.00	199	46.64	411	47.00	3	46.77
III + IV	20	48.65	3	48.33	—	—	26	46.73	3	46.67	—	—	164	46.23
V + VI	193	48.23	35	48.34	9	47.67	—	—	3	47.33	81	48.16	20	46.00
Total/Mean	295	47.86	1094	47.14	123	48.61	34	47.00	335	46.35	588	47.11	194	46.93

Area	Fladen Ground						Gut					
Month	III		VII + VIII		IX		III		VII		IX + X	
Stages of maturity	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.
I	147	46.27	131	46.45	—	—	163	45.92	69	46.09	13	46.38
II + VII + VII/II	245	46.69	19	47.00	84	46.92	57	46.75	—	—	579	46.44
III + IV	—	—	346	46.67	—	—	—	—	129	46.21	24	45.58
V + VI	3	44.00	42	46.86	9	46.56	—	—	—	—	11	45.82
Total/Mean	395	46.56	538	46.64	93	46.88	220	46.14	198	46.10	627	46.39

Area	Dogger Bank				Binnensee		Sandettié		Channel		Skagerak	
Month	IX		X		I		I		I		III + IV	
Stages of maturity	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.
I	57	45.91	308	45.82	8	46.00	—	—	—	—	70	46.33
II + VII + VII/II	306	46.30	782	46.21	91	45.59	5	44.80	6	45.00	36	47.03
III + IV	150	45.67	471	45.27	—	—	—	—	—	—	5	46.20
V + VI	155	46.03	131	45.77	—	—	80	45.38	16	45.25	2	44.00
Total/Mean	668	46.06	1692	45.85	99	45.63	85	45.34	22	45.18	113	46.50

Area	Egersund				Gr. Fisher Bank		Jutland Bank		
Month	III		VII		IX		III		IX
Stages of maturity	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.
I	303	46.09	15	46.53	—	—	49	46.16	59	45.14
II + VII + VII/II	310	46.69	5	47.00	—	—	37	46.00	—	—
III + IV	14	46.86	20	46.85	10	46.30	3	47.00	—	—
V + VI	13	46.92	1	45.00	70	46.01	6	47.50	—	—
Total/Mean	640	46.41	41	46.71	80	46.05	95	46.21	59	45.14

Area	East of Dogger								German Bight			
Month	I		III		VII		IX		VII		IX	
Stages of maturity	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.
I	50	45.58	23	45.26	74	45.06	357	45.47	70	45.04	6	45.83
II + VII + VII/II	38	46.03	—	—	—	—	2	45.00	—	—	2	47.00
III + IV	—	—	—	—	—	—	31	45.55	—	—	7	45.29
V + VI	—	—	—	—	—	—	9	46.11	—	—	7	46.57
Total/Mean	88	45.77	23	45.26	74	45.06	399	45.49	70	45.04	22	46.00

10. 'Binnensee'

337 herring, with an average length of 21.42 cm was investigated in January (Table 50). Maturity stages II, I, and VII/II formed the bulk of the catch (Table 51). The 4 and 2 year-old herring were the most abundant year-classes in this area (Table 52). The average number of the meristic characters were: vertebrae 56.60, keeled scales 14.84, and gill rakers 45.63 (Tables 53—55). The catch consisted of herring from the Downs group (Tables 56—58).

11. Sandettié and Channel

Only 108 herring were examined in January from these two areas. Fish in maturity stage VI were predominant (Table 51). Four year-old herring were the most abundant (Table 52). The average number of meristic characters (Tables 53—55) and the relation of these characters to the maturity stages showed that these fish belonged to the Downs group (Tables 56—58).

K. Schubert

The Herring Fisheries of the Netherlands in 1960

(Figure 12; Tables 59–60)

A. The Fisheries

Trawl

The catch and effort statistics for the herring-trawl fishery are summarized in Table 59, which shows the total catch (converted to fresh weight), the effort (in fishing hours, converted to those of a motor trawler of 500 BHP) and the catch per 100 hours fishing by month and by area. The areas are the same as those used in Ann. Biol., **16**, giving the material for 1959.

The trawl fisheries in 1960 were, in general, less successful than in 1959, with the exception of the spring fishery in the area NE, where catches were above normal. The summer and autumn fisheries in the areas NW and Central showed a serious decline, which may at least partly be attributed to a poor recruitment in these areas (see biological data).

In the area South, both the catch per effort and the total catch were lower than in 1959, but the catch per effort was still over the normal level observed in this area since 1955.

The total catch made by the herring trawlers declined from 61,800 tons in 1959 to 51,100 tons in 1960; the catch per effort from 30.7 tons per 100 hours fishing in 1959 to 19.1 tons in 1960.

Drift-net

Information on the drift-net fisheries is presented in Table 60, which gives catch and effort statistics by month for the same areas as used for the trawl fisheries.

In 1960, fishing started on 24. May. Up to

Table 59. Catch and effort data of the herring trawl fisheries in 1960

Top figures: total catch in tons.

Middle figures: effort in $\frac{\text{fishing hours}}{100}$ of a motor trawler of 500 B.H.P.

Bottom figures: catch per 100 hours' fishing.

Area	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
NE	1,371.4	2,530.8	3,329.1	1,174.1	839.2	481.8	43.1	525.5	354.8	2,613.6	2,107.2	1,186.9	16,557.5
	115.8	149.3	176.6	113.6	129.7	67.8	19.7	54.4	45.3	149.1	161.2	180.9	1,363.7
	11.8	16.9	18.8	10.3	6.5	7.1	2.2	9.7	7.8	17.5	13.1	6.6	12.1
NW	60.1	139.4	158.0	764.2	443.2	2,037.7	4,837.6	4,219.6	296.4	221.3	177.7	564.4	13,919.6
	5.0	8.2	11.9	62.3	65.5	108.5	148.4	120.8	13.8	9.5	13.7	17.8	585.6
	12.0	16.9	13.3	12.3	6.8	18.8	32.6	34.9	21.4	23.2	12.9	31.7	23.8
Central	1.2	8.7	26.8	24.9	52.9	320.5	1,290.4	4,179.9	10,400.3	1,729.3	86.2	—	18,121.1
	0.5	1.7	5.9	6.4	28.9	44.3	71.6	138.7	255.2	62.5	3.4	—	618.9
	2.3	5.2	4.6	3.9	1.8	7.2	18.0	30.1	40.8	27.7	25.7	—	29.3
South	—	—	3.7	—	—	—	—	128.9	—	—	386.1	897.0	1,415.8
	—	—	0.3	—	—	—	—	1.8	—	—	2.1	7.6	11.8
	—	—	13.8	—	—	—	—	72.4	—	—	183.9	118.1	120.5
SE Ireland .	—	15.3	—	0.8	—	—	—	157.8	151.8	233.4	30.5	544.9	1,134.7
	—	17.3	—	1.9	—	—	—	?	4.2	30.4	8.6	5.8	—
	—	0.9	—	0.4	—	—	—	?	36.6	7.7	3.6	94.6	—

Table 60. Catch and effort of drift-net fisheries 1960

Top figures: total catch in tons.
Middle figures: effort in numbers of shots.
Bottom figures: catch per shot in tons.

Area	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
NE						—							
NW	—	—	—	—	819.3	3,697.1	609.4	1,304.6	3,299.2	178.9	—	—	9,908.4
					499	1,793	330	320	588	38	—	—	3,568
	—	—	—	—	1.6	2.1	1.8	4.1	5.6	4.7	—	—	2.8
Central	—	—	—	—	—	1,233.8	4,263.7	5,030.9	3,633.7	3,113.0	6.1	—	17,281.2
						431	1,937	1,797	1,129	771	1	—	6,066
	—	—	—	—	—	2.9	2.2	2.8	3.2	4.0	6.1	—	2.8
South	—	—	—	—	—	—	—	—	—	6,058.6	7,739.4	765.9	14,563.8
	—	—	—	—	—	—	—	—	—	1,159	1,725	315	3,199
	—	—	—	—	—	—	—	—	—	5.2	4.5	2.4	4.6

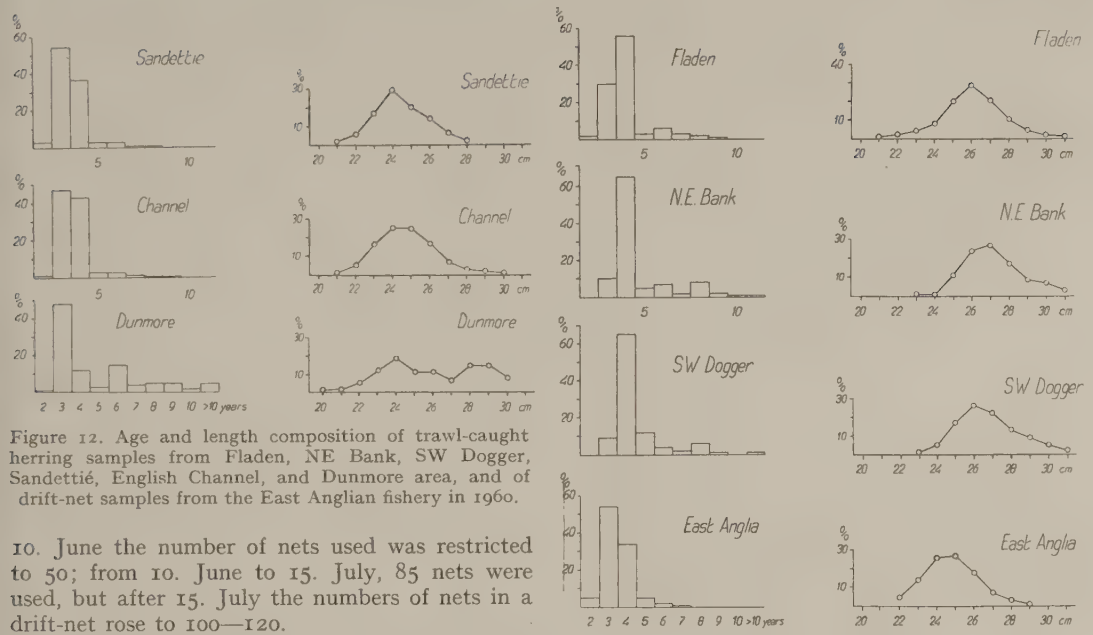


Figure 12. Age and length composition of trawl-caught herring samples from Fladen, NE Bank, SW Dogger, Sandettié, English Channel, and Dunmore area, and of drift-net samples from the East Anglian fishery in 1960.

10. June the number of nets used was restricted to 50; from 10. June to 15. July, 85 nets were used, but after 15. July the numbers of nets in a drift-net rose to 100—120.

The results of the drift-net fishery in 1960 can be briefly summarized as follows:—

The summer fishery (May/August), carried out in areas Central and NW, showed some decline in the catches, compared with 1959. Catches in area Central were somewhat higher than in area NW. In both areas the autumn catches (September/October) showed an improvement over 1959.

The fishery in the area South in late autumn improved considerably compared with 1959; the catch per effort almost doubled (4.5 against 2.4 tons), which means a return to the normal level of the catch per unit effort since 1955.

The overall picture of the drift-net fisheries reveals a slight improvement of the catch per effort, from 3.1 tons in 1959 to 3.3 tons in 1960. Due to a decline of the effort the total catch dropped from 49,300 tons in 1959 to 41,750 tons in 1960.

B. Biological Data

Age and length composition

As in the preceding years, sampling on a limited scale was carried out on the commercial catches. Sampling was restricted to the fisheries on some well defined fishing grounds.

The fisheries, selected for sampling, were:—

(1) *Fladen fishery*, period: July/August, area: North of 58°N; gear: herring trawl.

(2) *NE Bank fishery*, period: September, area: between 55°—56°N and 0°—1° W; gear: herring trawl.

(3) *The SW Dogger fishery*, period: September/October, area: 54°—55°N, 1°—2°E; gear: herring trawl.

(4) *East Anglian fishery*, period: October/December, area: 51°20′N—53°30′N; gear: drift-net.

(5) *Sandettié fishery*, period: November, area: Sandettié Bank; gear: herring trawl.

(6) *Channel fishery*, period: December, area: eastern part of English Channel; gear: herring trawl.

(7) *Dunmore fishery*, period: December 1960/January 1961, area: SE coast of Ireland; gear: herring trawl.

With the exception of the drift-net fishery in the East Anglian region and the trawl fishery in the Fladen area, all of these fisheries were concentrating on spawning herring.

In Figure 12 the age and length compositions are shown. The data for the Fladen and East Anglian fishery comprise all maturity stages; the data for the other fisheries are based on fish in maturity stage VI only.

Examing the data in Figure 12 it may be noticed:—

(1) That the 4 year-old herring (1956 year-class)

predominated in the catches in the central and northern North Sea and contributed a large part of the herring caught in the southern North Sea fisheries, the English Channel included.

(2) Recruitment of 3 year-olds (1957 year-class) was moderately good on the southern North Sea fisheries, but well below normal on the central North Sea stocks (Dogger and NE Bank).

Suggestive in this connection is the difference in success of the fisheries in the central northern North Sea and the southern North Sea.

(3) The discrepancy in age compositions, noticed in 1959 between the East Anglian fishery and trawl fisheries on the spawning grounds in area South (Sandettiè/Channel) did not recur in 1960 (see Ann. Biol., **16**).

The herring of the 1956 year-class, appearing in far too small numbers in the East Anglian fishery in 1959, as compared with the situation on the spawning grounds, did turn up in the East Anglian fishery in 1960, which means that the age compositions of the fisheries in area South were very similar, and, apparently, the normal pattern.

(4) The age composition in the Dunmore fishery reveals a good recruitment.

K. H. Postuma, J. J. Zijlstra

The Belgian Herring Fisheries in 1960—1961

A. The Fisheries

(Figures 13-14; Tables 61-73)

As in previous years, two different kinds of trawl were used, the otter-trawl and the pelagic trawl, the latter towed by two trawlers fishing together. The results obtained by these two fishing methods are given separately.

I. Otter-trawl; regions and periods

Four regions were exploited:—

(1) North Sea North — July, August.
(2) North Sea Central — August, September, October.
(3) The region N of Ireland — September, November.
(4) The region S of Ireland — October.

Fishing effort and landings

Tables 61—63 give records of the fishing effort and the yield of the fishery. Two trawlers made 13 trips and developed 584,370 FH x h. p. (In 1959—60, 7 trawlers made 31 trips and developed 1,914,670 FH x h. p.) (Table 61).

A total weight of 357.8 tons was landed of which 255.6 tons were herring (71.4%), 58.3 tons were

Table 61. Otter-trawl: Number of trips and fishing effort

Months	North Sea North	North Sea Central	N Ireland	S Ireland	Total
	Number of trips				
July	2	—	—	—	2
August	2	1	—	—	3
September ..	—	2	2	—	4
October	—	2	—	1	3
November ..	—	—	1	—	1
Total 1960 ..	4	5	3	1	13
	Fishing effort (1,000 FH × h. p.)				
July	69	—	—	—	69
August	70	47	—	—	117
September ..	—	119	85	—	204
October	—	118	—	35	153
November ..	—	—	41	—	41
Total 1960 ..	139	284	126	35	584

Table 62. Otter-trawl: Total yields in tons

Species	North Sea North	North Sea Central	N Ireland	S Ireland	Total Tons	Total ‰
Pelagic						
Herring ...	100.2	112.9	40.2	2.3	255.6	714
Mackerel ..	15.1	2.8	12.0	26.5	56.4	158
Others	—	—	—	1.9	1.9	5
Total	115.3	115.7	52.2	30.7	313.9	877
Demersal						
Total	12.5	15.7	14.6	1.1	43.9	123
Grand Total	127.8	131.4	66.8	31.8	357.8	1000

Table 63. Otter-trawl: Yields of herring

Months	North Sea North	North Sea Central	N Ireland	S Ireland	Total
	Total catch (tons)				
July	68	—	—	—	68
August	33	37	—	—	70
September ..	—	52	35	—	87
October	—	24	—	2	26
November ..	—	—	5	—	5
Total 1960 ..	101	113	40	2	256
	Average catch per trip (tons)				
July	34	—	—	—	34
August	16	37	—	—	23
September ..	—	26	17	—	22
October	—	12	—	2	9
November ..	—	—	5	—	5
Total 1960 ..	25	23	13	2	20
	Average catch per 100 FH × h.p. (kg)				
July	99	—	—	—	99
August	46	79	—	—	59
September ..	—	44	41	—	43
October	—	20	—	7	17
November ..	—	—	13	—	13
Total 1960 ..	72	40	32	7	44

other pelagic fish (16.3%) and 43.9 tons were demersal fish (12.3%) (Table 62). In the previous season 616 tons of herring were landed, this being 360.4 tons or 141% more than in 1960—61.

The average catch per trip for all regions together, reached 20 tons, and per 100 FH x h.p. 44 kg. In 1959—60, these figures were 20 tons and 32 kg respectively (Table 63).

II. Pelagic trawl; region and period

The use of the pelagic trawl was localized to the region Cape Gris-Nez to Schouwen Bank, a small area off the French, Belgian, and Netherlands coasts. The first catches were landed on 24. October 1960 and the last on 13. January 1961. The season asted 82 days, with 40 market days. From October to 16. December, the fishery took place off the French and Belgian coasts, viz. in the vicinity of Cape Gris-Nez, East Dyck, Outer Ratel, East-Hinder, Fairy, and West-Hinder Banks. From 16. December 1960 to the end of the season the fishery took place off the coast of Netherlands, viz. the Thornton Ridge, Middle Bank, and Schouwen Bank.

Fishing effort and landings

Table 64 gives a survey of the fishing effort. In this season, 13 pairs of vessels took part in the fishery. A total of 256 voyages were made, and 104,560 V × h.p. (V = voyages) were developed. (In 1959—60, 13 pairs made 234 voyages and developed 103,330 V × h.p.).

The total catch amounted to 2,710 tons, consisting of 2,508 tons of herring (92.5%), 15 tons of other pelagic fish (0.6%), and 187 tons of demersal fish (6.9%) (Table 65). (In 1959—60 2,164 tons of herring were landed.)

The average catch per voyage was 9.8 tons and per 100 V × h.p. 2,399 kg; in 1959—60 it was 9.3 tons and 2,095 kg, and in 1958—59, 7.4 tons and 1,731 kg respectively (Table 66).

B. Biological Data

A total of 950 herring were analysed. They were collected from catches made in the southern North Sea by trawlers using the pelagic trawl (Sandettié area) — 420 in November, 420 in December, and 110 in January.

Table 67 shows the length distribution of the herring for each month. The average weight and the percentage number of males is also recorded, together with the average length of the fish.

Table 68 gives the stages of maturity for these months. As in previous years the quantity of intestinal fat was also estimated. The data are shown in Table 69.

Table 64. Pelagic trawl: Number of trips and fishing effort

Months	Number of trips	Fishing effort (1,000 V × h.p.)
October	21	8.8
November	124	49.9
December	109	44.8
January	2	1.0
Total 1960–61	256	104.5

Table 65. Pelagic trawl: Total yields

Species	Tons	‰
Pelagic		
Herring	2,508	925
Mackerel	2	1
Pilchard	8	3
Sprat	5	2
Demersal		
Cod	147	54
Whiting	31	11
Others	9	4
Total pelagic species	2,523	931
Total demersal species	187	69
Grand total	2,710	1000

Table 66. Pelagic trawl: The yields of herring

Months	Total catch (tons)	Average catch per voyage (tons)	Average catch 100 V × h.p. (kg)
October	350	16.7	3,963
November	1,345	10.8	2,693
December	792	7.3	1,770
January	21	10.3	2,060
Total 1960–61	2,508	9.8	2,399

Table 67. Length, weight, and sex (‰)

Cm	November	December	January
30	—	—	9
29	2	—	—
28	14	14	—
27	50	38	73
26	129	126	209
25	245	**310**	**291**
24	**313**	212	227
23	193	136	118
22	52	55	55
21	2	81	9
20	—	26	9
19	—	2	—
Total	1000	1000	1000
Average length, mm	249	246	252
Mode, cm	24	25	25
Weight, g	122	105	102
Males, ‰	479	502	445

Table 68. Stages of maturity (‰)

Stages	November	December	January
I	40	—	—
II	40	—	—
III	—	—	—
IV	17	—	—
V	302	26	—
VI	**336**	288	—
VII	10	19	18
VIII–II	255	**667**	**982**
Total	1000	1000	1000

Table 69. Quantity of intestinal fat (‰)

Quantity	November	December	January
0	212	224	64
1	**669**	**776**	**936**
+	52	—	—
M	67	—	—
Total	1000	1000	1000
Index	1.97	1.78	1.94

Table 70. Age (‰)

Age	Year-class	November	December	January
2	1958	17	18	—
3	1957	**562**	**578**	**500**
4	1956	368	357	427
5	1955	39	26	46
6	1954	14	16	18
7	1953	—	5	—
8	1952	—	—	—
9	1951	—	—	—
10	1950	—	—	—
+10	<1950	—	—	9
Total		1000	1000	1000
Average age (years-months)		3.6	3.6	3.7

Table 72. Vertebrae (VS ‰)

VS	November	December	January
59	2	—	—
58	50	62	39
57	**465**	**506**	**641**
56	450	388	291
55	28	44	29
54	5	—	—
Total	1000	1000	1000
Average	56.535	56.585	56.689
Standard error	0.6704	0.6741	0.5914
Fluctuation mean	0.1133	0.1130	0.1965

Table 73. Keeled scales (K_2) in ‰

K_2	November	December	January
18	—	2	9
17	20	22	27
16	170	139	200
15	**451**	**480**	500
14	295	307	218
13	62	48	46
12	2	2	—
Total	1000	1000	1000
Average	14.782	14.779	14.973
Standard error	0.8742	0.8450	0.8894
Fluctuation mean	0.1464	0.1415	0.2859

Table 71. Average lengths by age and the value of L_1 (mm)

	Average length by age, in mm				Average value of L_1, in mm		
Year-class	November	December	January	L_1	November	December	January
1958	229	210	—	1958	152	144	—
1957	240	237	242	1957	129	126	128
1956	259	257	259	1956	119	116	116
1955	273	272	272	1955	122	128	121
1954	280	274	277	1954	119	119	117
1953	—	283	—	1953	—	118	—
1952	—	—	—	1952	—	—	—
1951	—	—	—	1951	—	—	—
1950	—	—	—	1950	—	—	—

The age composition of the catches is shown in Table 70. Three year-old fish were predominant during each of the three months.

The average length of the herring and the growth-rate during the first year (L_1) is given in Table 71.

The numbers of vertebrae are given in Table 72. These varied between 54 and 59 but fish with 57 vertebrae predominate.

Finally, Table 73 gives the number of keeled scales (K_2) for the three months.

Only 10 stomachs were found to contain food, mostly remains of fish larvae.

C. Conclusions

In relation to the fishing effort, the herring catches in the southern North Sea seem to have been more abundant than during the two previous seasons.

As in the last three seasons usually the same trawlers have been taking part in the herring fishery in this area and as the fishing method did not change appreciably, it must be concluded that the herring concentrations were of greater density during 1960—61.

This seems to be mainly the result of the high frequency of the 4 year-old herring (1956 year-class) which made up 37.1% of the catches in the 1960—61 season, whereas the 1959—60 catches were composed of only 10.1% 4 year-old herring (1955 year-class). It is to be noted that since the 1956—57 season, an abnormally high frequency of the 3 and 4 year-old herring has been observed in the catches (Figures 13 and 14).

The vertebral count data for December 1960, and especially for January 1961, probably indicate

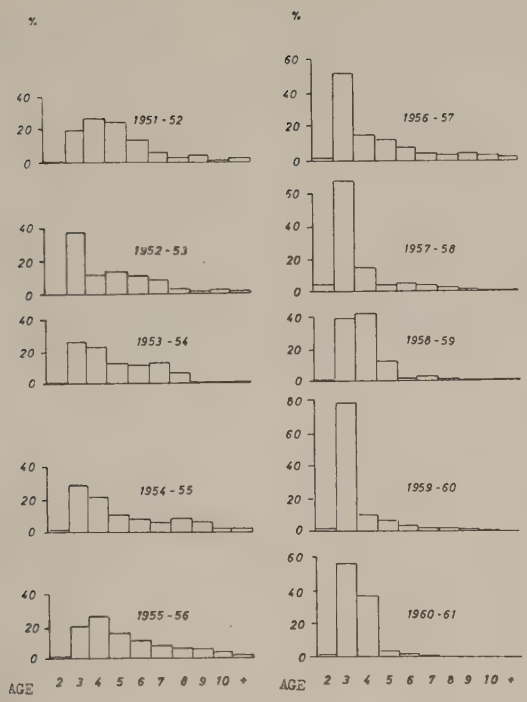


Figure 13. Age compositions during the period 1951/52 to 1960/61.

a fairly large penetration of Channel herring into the southern North Sea.

It may be presumed that the herring of the 1957 and 1956 year-classes, which in the coming season will be 4 and 5 years old, will once again be numerous and the older year-classes nearly totally absent. Concerning the 1958 year-class it is not possible to estimate its probable density as these herring, as 3 year-olds, will recruit the spawning concentrations for the first time in 1961—62. If this young year-class is well represented, the results of the forthcoming season may well by more favourable than the preceding one.

The success of the 1961—62 herring season may naturally be greatly influenced by the meteorological and hydrological conditions prevailing at the time of the fishery.

Ch. Gilis

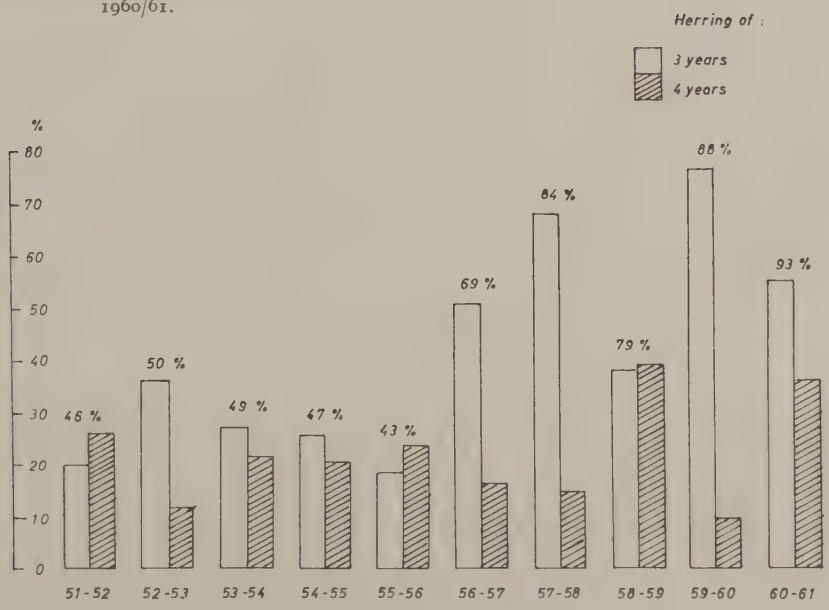


Figure 14. The frequency of 3 and 4 year-old herring during the period 1951/52 to 1960/61.

Table 74. Length composition of Swedish herring samples in 1960

Area	Skagerak		E. North Sea			W. North Sea							Kattegat	
Gear	Pelagic pair-trawl		Pelagic pair-trawl			Bottom-trawl							Pound-net	Drift-net
Square	P 14	P 15	J 15	J 15	J 15	E 17	F 17	E 19	G 17	E 14	E 17	E 20	Q 13	Q 13
Date	10. 10.	13. 12.	15. 1.	18. 3.	18. 11.	21. 7.	29. 7.	5. 8.	16. 8.	25. 8.	27. 8.	9. 9.	28. 9.	12. 10.
Cm 12.0 ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—
.5 ...	2	—	—	—	—	—	—	—	—	—	—	—	—	—
13.0 ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—
.5 ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—
14.0 ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—
.5 ...	—	2	—	—	—	—	—	—	—	—	—	—	—	—
15.0 ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—
.5 ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—
16.0 ...	—	2	—	—	—	—	—	—	—	—	—	—	—	—
.5 ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—
17.0 ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—
.5 ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—
18.0 ...	—	4	—	—	—	—	—	—	—	—	—	—	—	—
.5 ...	6	4	—	—	—	—	—	—	—	—	—	—	—	—
19.0 ...	37	9	—	3	—	—	—	—	—	—	—	—	—	—
.5 ...	61	2	—	3	—	—	—	—	—	—	—	—	—	—
20.0 ...	110	14	—	14	4	—	—	—	—	—	—	4	—	—
.5 ...	135	25	10	3	—	—	—	—	—	—	—	—	—	—
21.0 ...	184	44	5	11	—	3	—	—	—	—	—	—	—	—
.5 ...	141	82	7	33	17	—	—	—	5	—	—	—	—	6
22.0 ...	116	97	22	45	17	—	—	—	—	—	—	—	17	—
.5 ...	78	97	19	45	8	—	—	—	—	—	—	—	64	13
23.0 ...	59	97	29	59	8	—	—	—	—	—	—	—	35	51
.5 ...	29	127	41	98	—	—	—	—	—	—	—	—	41	51
24.0 ...	26	94	55	100	21	—	—	—	—	—	3	—	52	25
.5 ...	4	90	89	117	25	11	5	—	—	7	21	—	12	13
25.0 ...	2	43	125	106	42	32	9	—	—	18	46	—	23	6
.5 ...	2	36	103	92	59	71	46	5	5	36	85	4	12	19
26.0 ...	—	15	165	81	98	142	79	—	5	86	121	18	35	44
.5 ...	2	10	103	47	132	177	106	27	34	104	157	51	76	121
27.0 ...	2	21	70	33	124	145	153	22	58	227	167	157	110	166
.5 ...	2	29	38	17	111	177	143	104	127	183	157	154	81	178
28.0 ...	—	24	34	20	90	124	97	142	117	126	50	187	122	108
.5 ...	—	12	19	14	51	64	88	115	210	72	39	88	64	64
29.0 ...	—	5	22	14	81	18	83	126	88	29	36	99	52	32
.5 ...	—	4	12	17	38	14	60	115	117	18	28	92	35	13
30.0 ...	—	3	12	6	21	14	32	126	98	32	39	33	52	51
.5 ...	—	2	12	14	13	—	28	93	44	32	28	40	29	25
31.0 ...	—	3	2	8	21	—	28	60	49	18	11	26	47	6
.5 ...	—	2	—	—	—	—	32	49	24	11	11	18	17	—
32.0 ...	—	1	7	—	8	7	5	11	5	—	—	22	12	6
.5 ...	—	—	—	—	4	—	5	5	15	—	—	4	12	—
33.0 ...	—		—	—	8	—	—	—	—	—	—	4	—	—
Total ‰ ..	998	1000	1001	1000	1001	999	999	1000	1001	999	999	1001	1000	998
No. analysed	489	426+ +301	417	358	236	282	216	183	205	278	281	273	172	157

The Swedish Herring Fishery in the North Sea, Skagerak, and Kattegat in 1960

(Figures 15–18; Tables 74–77)

According to preliminary figures, the total yield in 1960 amounted to about 114,450 tons. Practically all was taken by trawl (bottom trawl and pelagic pair-trawl); only about 0.25 % by other gears.

As in the preceding year most of the fishery took place in the North Sea.

Some data, concerning catch per unit of effort in the Swedish herring fishery have been reported in the *Statistical News Letters*.

This report deals with the results from the examination of 14 samples from commercial catches in different parts of the area and at different times of the year. Some 10 samples of Skagerak spring spawning herring, as well as some samples from the Norwegian winter herring fishery off Kristiansund N are not included here.

On the whole, the fishing grounds were the same as in 1959 only that the bottom trawl fishery in summer and early autumn extended farther north to cover also the statistic squares E 18, E 19, E 20.

The Skagerak

As in preceding years, ever since 1955, the fishery in the Skagerak has been pursued mainly on young herring. The length distributions of samples taken on two occasions in the autumn are given in Table 74 and Figure 15, in which the age composition is also given. The maturity stages and the mean vertebral counts are given in Table 75. The 1-ringers are strongly predominating. The values of VS indicate a mixture of North Sea herring and Skagerak spring spawners.

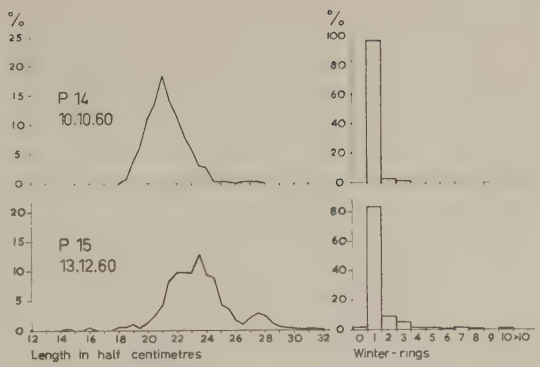


Figure 15. Length and age composition of pelagic pair-trawl samples from the Skagerak.

Eastern part of northern North Sea

Three samples, all of which were from the Egersund Bank (Tables 74 and 76, Figure 16). The bulk of them were in stage II and had a mean vertebral count of about 56.5 thus showing that they belonged to the North Sea Bank herring, of which the 1956 year-class is still predominating. Two of the samples also contained a smaller portion of fish in stages III and IV and with VS averaging 57.0. These undoubtedly belonged to the Skagerak spring spawning group with the exception of one single fish which according to the type of the scales was a Norwegian winter herring.

Western (and middle) part of northern North Sea

Seven samples, taken at intervals from late July to early September, were analysed (Tables 74 and 77; Figure 17). The majority of these herring were Bank herring, but as usual a small number of spring spawners might be contained in the samples as the mean vertebral counts suggest (Table 76). The 1956 year-class of the Bank herring is still strongly predominating. Obviously the recruit year-class of 1957 is very poor.

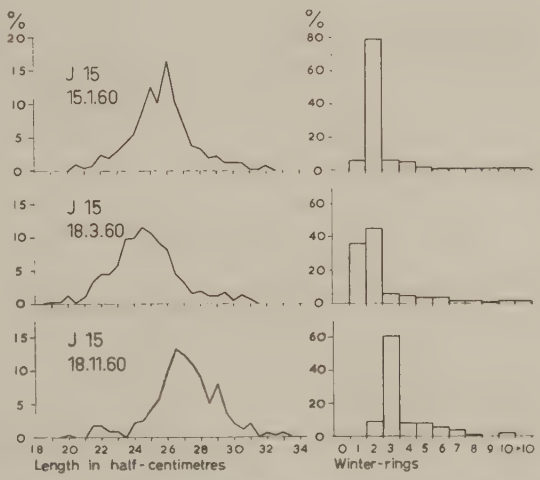


Figure 16. Length and age composition of pelagic pair-trawl samples from the eastern part of the northern North Sea.

Table 75. Total number of vertebrae (VS) in relation to maturity stages

Area	Skagerak				Kattegat			
Gear	Pelagic pair-trawl				Pound-net		Drift-net	
Square	P 14		P 15		Q 13		Q 13	
Date	10. 10. 60		13. 12. 60		28. 9. 60		12. 10. 60	
Stage	No.	VS	No.	VS	No.	VS	No.	VS
I	234	56.85	163	56.90	—	—	—	—
II	2	56.00	23	56.46	—	—	2	56.50
III	6	56.17	8	57.17	12	56.08	—	—
IV	2	55.50	7	57.35	118	56.21	2	56.00
V	—	—	—	—	15	56.20	20	56.00
VI	—	—	—	—	—	—	110	56.26
VII	1	57.00	1	57.00	—	—	8	56.12
VII–II	1	57.00	—	—	1	57.00	—	—
Total/Mean	246	56.82	202	56.88	146	56.20	142	56.22

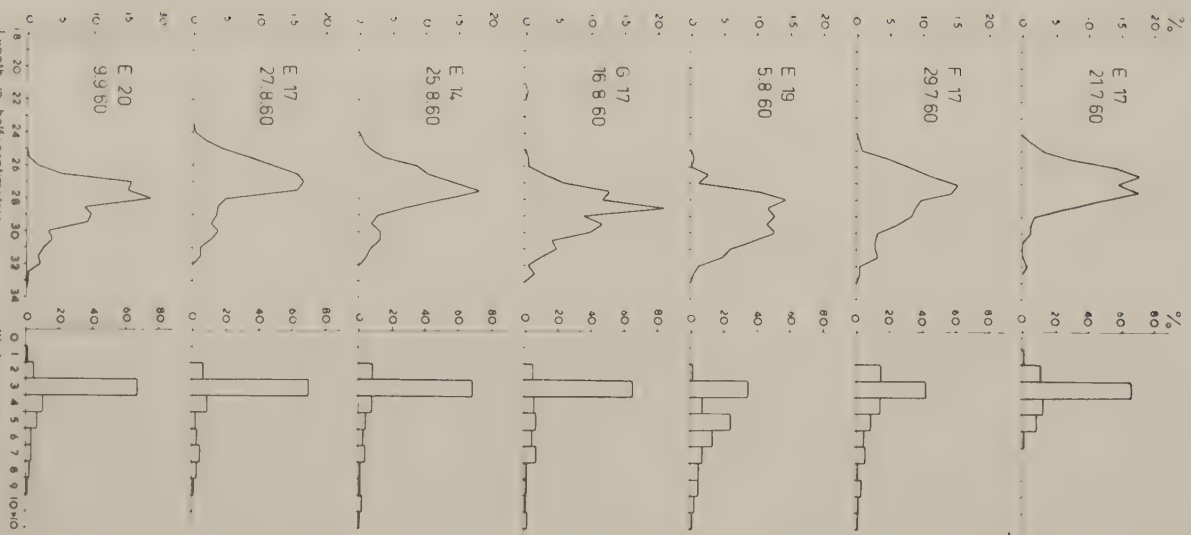


Figure 17. Length and age composition of bottom trawl samples from the western part of the northern North Sea.

Table 77. Total number of vertebrae (VS) in relation to maturity stages

Area	Western part of northern North Sea													
Gear	Bottom trawl													
Square	E 17		F 17		E 19		G 17		E 14		E 17		E 20	
Date	21. 7. 60		29. 7. 60		5. 8. 60		16. 8. 60		25. 8. 60		27. 8. 60		9. 9. 60	
Stage	No.	VS	No.	VS	No.	VS	No.	VS	No.	VS	No.	VS	No.	VS
I	4	57.00	—	—	—	—	3	57.00	1	57.00	—	—	3	57.00
II	6	57.00	42	57.24	3	57.00	45	56.96	66	56.48	43	56.51	110	56.62
III	22	56.50	23	56.51	4	56.75	23	56.91	2	57.00	1	58.00	27	57.04
IV	146	56.58	114	56.47	142	56.62	40	56.45	7	56.71	14	56.54	6	57.00
V	17	56.35	6	56.17	14	56.50	3	55.67	4	57.00	4	56.75	—	—
VI	—	—	—	—	—	—	—	—	5	56.40	—	—	—	—
VII	—	—	—	—	—	—	10	57.00	25	56.68	20	56.70	3	56.33
VII–II	—	—	—	—	—	—	47	56.49	86	56.51	54	56.70	92	56.63
Total/Mean ..	195	56.57	185	56.64	163	56.62	171	56.68	196	56.55	136	56.65	241	56.68

Table 76. Total number of vertebrae (VS) in relation to maturity stages

Area	Eastern part of northern North Sea					
Gear	Pelagic pair-trawl					
Square	J 15		J 15		J 15	
Date	15. 1. 60		18. 3. 60		18. 11. 60	
Stage	No.	VS	No.	VS	No.	VS
I	15	56.60	66	56.56	5	56.40
II	161	56.53	138	56.48	120	56.53
III	8	56.75	1	56.00	5	57.20
IV	6	57.16	—	—	25	57.04
V	—	—	—	—	—	—
VI	—	—	—	—	—	—
VII	1	56.00	—	—	—	—
VII–II ..	—	—	2	56.00	—	—
Total/ Mean .	191	56.56	207	56.50	155	56.63

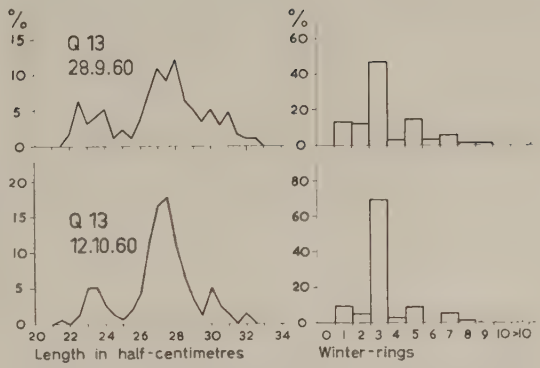


Figure 18. Length and age composition of one pound-net sample (28. 9. 60) and one drift-net sample (12. 10. 60) from the Kattegat.

The Kattegat

One sample obtained from a Danish pound-net at the NE point of Læsø on the 28. September (strictly speaking this sample is of course not Swedish caught) and another sample from the Swedish drift-net fishery on the Groves Flak, SE of Læsø on the 12. October have been examined (Tables 74 and 75, Figure 18). The two samples undoubtedly belong to the same group, the Kattegat autumn spawners, which is clearly suggested by the mean vertebral count and the maturity stages, and also by the K_2 which was found to be 14.26 in the first sample and 14.22 in the second.

HANS HÖGLUND

C. Skagerak, Kattegat, and Baltic-Belt Seas

Young Stages

Some Data on the Growth of Larvae and Young of Spring and Autumn Herring (Salaka) in Riga Gulf

(Tables 78–80)

Data on the biology of herring (salaka) of Riga Gulf, collected in 1955/60 permit us to describe the pattern of its growth during the first year of life, with regard to both size and weight (in relation to the stages of development of fry and regime of the basin). The characteristics are given for the populations of mass hatching.

(a) Spring spawning salaka (Tables 78-79)

Prior to the formation of fry (July/August) larvae remain in the inshore zone. The daily length increment is 0.5 mm and the weight increment averages 1.5 mg. The fry stage begins at a length of 30—31 mm, and weight of about 70 mg; at this time a sharp rise in weight is observed: whereas a larva of 31 mm length weighs 75 mg, a fry of 34 mm weighs 170 mg. After the formation of fry is completed they leave the coastal zone for deeper waters (35—40 m). The rate of increase in weight in August/October is very high: by October young fish reach a length of 55—57 mm, and a weight of about 2 g. Fry do not grow in winter.

Differences in weight (by the length/weight ratio) of larvae is found to be connected with the time of hatching. Thus, larvae at an age of about one month and a length of 25 mm weigh 22 mg in early-hatched populations, and 28 mg in populations of mass (late) hatching. This may be ascribed to the differences in food availability.

In general, the differences in fat content of larvae

Table 78. Average length and weight of larvae and fry of spring salaka in Riga Gulf

Month		May	June	July	Aug.	Sept.	Oct.	Nov.
First feeding season	Length, mm	9	15	30	43	55	62	—
	Weight, mg	0.2	5	70	510	1,300	1,600	—
Second feeding season	Length, mm	—	65	—	—	84	—	96
	Weight, mg	—	2,000	—	—	4,700	—	7,000

Table 79. Average weight (in mg) of spring spawned salaka larvae in Riga Gulf in different years

Years	Length in mm 16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
1957	4	5	6	7	9	10	13	16	20	26	31	36	46	56	70	87	109
1958	4	5	6	7	9	11	14	18	22	25	30	38	48	60	73	87	104
1959	4	5	6	8	10	11	15	17	21	25	30	36	44	53	66	80	97
1960	4	5	7	9	12	15	19	24	28	35	40	55	66	85	101	113	138

Table 80. Average length and weight of autumn spawned salaka larvae in Riga Gulf

Month	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.
Length, mm	10	17	25	28	31	32	—	32	—	36	39	46	51	67	74	83
Weight, mg	0.3	12	24	36	53	56	—	53	—	90	170	319	1,090	2,770	3,440	4,300

between years are not very great (Table 79) in spite of highly variable weather conditions (sequence of warm and very cold years).

The rate of growth of fry during their first autumn is greatly affected by the regime in the basin: in 1954, 1956, and 1958 — years of low zooplankton abundance — the average lengths of fry (0+) were 57, 59, and 60 mm respectively, whereas in 1955, 1957, and 1959 — years of high zooplankton abundance — the average lengths were 75, 71, and 67 mm respectively.

The rate of growth during the first feeding season of the young is correlated with the numerical strength of the year-classes: rich year-classes have larger yearlings in comparison with poor generations.

(b) Autumn spawning salaka (Table 80)

The rate of growth of autumn spawning salaka depends on the time of hatching: populations hatching in September show an average daily length increase of 0.5 mm, while for those hatching in October the increase is 0.3 mm. In November/December, when the water is cooled to 4—5° C, the larvae move from the coastal zone to the zone 30—45 m deep, where they remain in the upper layers (1 to 10 m). The average length of larvae at this time is 24—28 mm and the average weight from 16 to 38 mg (depending on the time of hatching of certain populations). From December their growth is halted until spring (April/May) and their fat content decreases, although larvae continue to feed during winter as well: on average, 50 to 60% of them have food in their intestines (water temperature ranging from 0.5 to 4° C).

In June, when the larvae are again found in the coastal zone, they enter the stage of fry development (at this time the larvae have greater length than those of spring spawning salaka). During this period, the larvae have a length of 38—42 mm and a weight of 100—200 mg. From this moment the rate of growth, both in terms of size and, especially weight, increases sharply.

L. N. Lisivnenko

Danish Investigations in the Skagerak, Kattegat, Belts, and Baltic in 1960

(Table 81)

(1) Young herring in the Limfjord

In the Limfjord, catches of herring of about 13.5 cm length, in the western part of the Nissum Broad, in October, consisted of Downs herring, but a catch from the Livø Broad, north of Fur, in November, consisted of pure Limfjord spring spawners. Two catches, from Hvalpsund in November/December, of herring about 10—17 cm long, were composed of two different racial groups, although their lengths were centred rather sharply around a mean of 12.5 cm; those of 9—12 cm were Limfjord spring spawners, and those over 13 cm were North Sea autumn spawners (no doubt also Downs herring, but mixed with an about equal part of the spring spawners). Samples of about the same length from near Venø in October were also composed of a mixture of the two races, but with higher percentage of the North Sea herring. The vertebrae of the larger sizes have not yet been counted.

(2) Young herring in the Skagerak and northern Kattegat

In February, the herring of 10—19 cm, fished in the Skagerak were a mixture of spring herring of the Atlanto-Scandian type and North Sea autumn spawners. Actually their VS and K_2 (shown in Table 81) were very near to those of the West Channel late autumn spawners, but the VP was too high for this race. A division of the herring into size groups, shows that the smaller ones were spring spawners and the larger ones autumn spawners. Thus, the K_2 for herring of 10—13 cm and 14—15 cm was 14.26 (57) and 14.11 (133) respectively, whereas the K_2 for those of 16—19 cm was 14.59 (128). Unfortunately, the herring were not divided into size groups for vertebral counts. Samples from the Skagerak on 21. March gave the same mixture. In 1960, almost all of the North Sea herring found in the Skagerak were young fish.

Two samples of herring from the northern Kattegat on 18. February, consisted of Kobbergrund

Table 81. Racial characters of young herring caught in Danish waters in 1960

	Number of samples	Depth, m	Length, cm	VS	Number	VP	K_2	Number
			The Limfjord					
10. Oct. Round Venø	2	6–7	10–12	56.32	44	23.80	14.67	66
10. Oct. Round Venø		7	13–16				14.58	38
11. Oct. Nissum broad	2	5–7	13–16	56.64	75	23.89	—	—
21. Nov. N of Fur, Livø broad	1	10	11–14	55.87	76	23.68	14.11	65
22. Nov.–15. Dec. Hvalpsund	2	10–19	9–11	55.77	104	23.55	13.88	43
22. Nov.–15. Dec. Hvalpsund			12	55.99	107	23.43	14.01	135
22. Nov.–15. Dec. Hvalpsund			13–18	56.25	28	23.93	14.68	115
			Skagerak and northern Kattegat					
16. Feb. Skagen-Hirtshals	4	38–75	10–19	56.71	372	24.36	14.43	318
18. Feb. Off Fredrikshavn	2	24–39	9–16	56.40	116	24.31	14.56	98
26. Apr. E of Læsø	1	39	13–19	56.26	111	24.21	—	—
27. Apr. S of Frederikshavn	1	5	11–15	56.21	71	23.76	—	—
27. Apr. S of Frederikshavn			16–20	56.32	34	23.52	14.2	23
14. July S of Frederikshavn	1	5	8–12	56.41	160	23.97	—	—
14. Sept.–31. Oct. NW of Skagen-Hållö	2	85	18–21	57.14	42	24.26	14.0	19
14. Sept.–11. Oct. N and NW of Skagen	2	113–132	17–26	56.79	79	24.40	14.36	97
21. Oct. Off Frederikshavn	1	30	14–20	56.45	102	23.88	14.47	173
18. Nov. NW of Skagen	1	92	19–25	56.65	134	23.87	14.45	129
			Southern Kattegat					
24. Feb.–25. Apr. Isefjord	4	8–20	16–23	55.82	399	23.40	13.90	410
17. Oct. N of Seeland	1	21	19–23	56.09	108	23.27	14.14	106
			The Belts					
2. March–5. May Århus Bay	3	13–32	8–18	56.01	330	23.93	14.23	261
15. Nov.–7. Dec. Århus Bay	2	12–20	8–17				14.17	149
9. Dec. S Little Belt	1	40	10–17	55.74	132	24.08	14.24	201
			Baltic proper					
13. Sept. W of Rønne	1	40	10–20	55.63	59	23.76	13.62	46

herring. In April some herring of 11—20 cm caught in pound-nets, south of Frederikshavn had VS 56.22 (105), VP 24.33 (104), and K_2 14.17 (23) but a separation at 16.0 cm shows that the larger were Kobbergrund herring and the smaller ones Kattegat (or Belt Sea) spring spawners. Undoubtedly a similar mixture is found in a sample from east of Læsø in April (Table 81). In June/July small herring of 8—11 cm were caught in pound-nets at Frederikshavn, and in a catch from 21. October, also from the northern Kattegat, the same herring (then about 16 cm long) were found. The racial characters show that they were Shetland-Scotland autumn spawners.

In September/October, catches from the Skagerak again contained herring of the Atlanto-Scandian type, their length then being about 20 cm. In two of the catches from 85 m depth, they seemed to be pure Norwegian spring (winter) spawners, but only 42 were investigated, and in two catches from 113—132 m depth they were Kattegat winter spawners.

(3) Isefjord (southern Kattegat)

The 13—24 cm herring, caught in January/April were 0- and I-group but belonged to the same race. From Table 81 it is seen that they were Kattegat or northern Belts spring spawners.

(4) Young herring in the southern Kattegat, Belts, and Baltic

Catches from Århus Bay in March/May were 0- and 1-ringed herring of 8—18 cm length. They were mainly Kattegat or northern Belts spring herring, but especially the high VP indicates a small mixture with Kobbergrund herring. Catches from November/December appeared to consist of the same herring but the vertebrae have not been counted as yet. Herring caught in the southern Little Belt in February were local autumn spawners.

A catch of 10—20 cm herring from west of Rønne in September, consisted of Baltic autumn spawners, but some had many rings, which, together with the low K_2, indicates an admixture with coastal spring spawners. The number sampled was too low to allow a more close analysis.

AAGE J. C. JENSEN

Adult, Commercial Fish

Table 82. Length, age, maturity, and racial characters of adult herring caught for human consumption in 1960

(D = Drift-net; P = Pound-net; T = Trawl)

Month	Locality	Gear	Depth, m	Maturity	Length, cm	Number of rings	VS	n	VP	K_2	n
Nov.	Limfjord, Livø Br.	T	10	III,	20–26	2	56.08	59	23.75	14.24	59
				IV–VII	20–27	2	56.01	84	23.65	14.33	84
Apr.	North of Seeland	P	5	V–VII	21–29	1–2	56.18	157	23.67	14.11	156
Apr.	Isefjord	P	5	I–III	18–24	1	56.97	35	23.49	14.17	47
				IV–VIII	19–27	1(–2)	56.03	159	23.45	13.96	158
Oct.	NW of Odden	D	20	III–VIII	22–33	3	55.94	112	24.70	14.32	107
Sept.	E of Bornholm	D–T	60	I	17–22	1–2	55.52	27	23.83	13.77	26
				II–IV	17–26	1–7	55.47	100	23.92	13.65	96
				V–VIII	17–26	1–7	55.51	114	23.84	14.13	113

Adult Herring in the Limfjord, Kattegat, Belts, and Baltic

(Table 82)

Very few adult herring were caught by Danish fishermen in the Skagerak and no samples of them were analysed. A sample of herring, 20—27 cm long caught by trawl in the Livø Broad, in the Limfjord, in April, consisted mostly of 2-ringed herring of 20—27 cm length. About 10% were immature, 65% maturing, and the remainder almost mature. The VS was very much higher than that of the Limfjord spring spawners, which indicates an admixture of North Sea autumn spawners, which were encountered among the smaller herring (see Young Stages). Of the spring spawning herring at North Seeland, two samples were investigated in April. The herring in one of them, from the Kattegat coast near Hundested, contained a small component of young herring, of about 21 cm length, but which were too few for their type to be determined. However, the major part, consisting of herring of 21—29 cm length, were 2-ringed members of the large Kattegat spring herring, which mostly spawn in the northern Kattegat, but is often found spawning in the southern Kattegat. The other sample was taken in the Isefjord in April. Most of the fish were 1-ringed but some were 2-ringed and a few older. All were southern Kattegat or northern Belts spring spawners.

Of the autumn spawners at the northern entrance to the Belts, a catch in drift-nets taken NW of Odden in October were between 22 and 33 cm long. They were typical, large Kattegat autumn herring with high VP, which have only been found spawning in this region a few times previously. Most of them were 3-ringed.

Herring caught east of Bornholm in anchored drift-nets and trawl in September were between 14 and 28 cm long. Their age composition was as follows:—

Rings	Maturity stage I	II–IV	V–VIII
0	1		
1	16	21	12
2	12	17	56
3	6	12	20
4	2	13	12
5	5	16	9
6	—	11	4
7	1	9	—
8	—	5	—
9	—	3	—
10	—	—	—
11	—	—	1
Total	43	107	114

From Table 82 it is seen that the mature fish had the racial characters of the autumn spawners from the Bornholm region. Of the immature fish about 70% were in maturity stages I and II and 20% in stage IV. Their VS and VP were the same as the mature herring, but their low K_2 indicates a mixture with spring spawners. A high number of them had many rings on the scales, even with lengths below 20 cm, which shows that many of them belong to the slow growing herring of the central and inner Baltic.

AAGE J. C. JENSEN

Soviet Herring Investigations in the North-Eastern Baltic in 1960

(Figure 19; Tables 83–85)

In 1960, samples of herring larvae were collected with a Hensen net at regular intervals at stations situated on the spawning grounds of spring spawning herring in the north-eastern part of the Gulf of Riga. During the spring spawning season (May to June) 66 samples, and during the autumn spawning season (August to October), 49 samples were taken. The numbers of spring larvae were a little greater than in 1958 but less than in 1957

Table 83. The average numbers of herring larvae per 10 min. haul with the Hensen net in the north-eastern part of the Gulf of Riga

Year	1958	1959	1960
Spring herring	14.0	35.6	27.3
Autumn herring	37.4	100.5	7.0

Table 84. The yields of herring in the Estonian SSR in 1957–1960

	Coastal catches				Trawl catches	Total
	Spring herring		Autumn herring		(Tons)	(Tons)
	Tons	%	Tons	%		
1957	25,641	90.0	2,864	10.0	3,816	32,321
1958	19,246	87.1	2,848	12.9	3,093	25,187
1959	16,018	86.1	2,582	13.9	4,723	23,323
1960	14,195	89.4	1,681	10.6	4,520	20,396

and 1959. The numbers of autumn larvae were very small in the catches. The average number of herring larvae per 10 min. haul with the Hensen net is given in Table 83.

In Table 84, the yields of the herring in the Estonian SSR are shown, as well as the relative strength of the two seasonal races represented in the catches. In comparison with spring spawners, the proportion of autumn spawners is much smaller, usually giving only 3—5% of the total yield. In 1957—1959 however, the catches of the autumn herring reached a considerably higher level.

In 1960, a total of about 4,800 spring spawners and 2,300 autumn spawners from the coastal fishery, and 1,000 herrings from trawl catches were investigated. The age composition of the spring and autumn herring can be seen in Figure 19.

The main body of the spring herring catches consisted of the abundant 1957 year-class; the 1958 year-class appeared to be modest and the 1956 year-class poor. The catches of autumn herring,

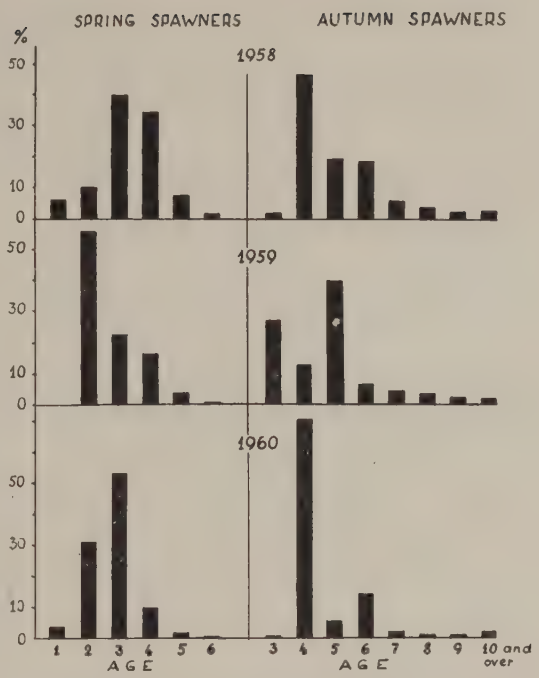


Figure 19. The age composition of spring herring (from Cacuam catches) and autumn herring (from fixed net catches) in the north-eastern part of the Gulf of Riga.

were based on the abundant 1956 year-class, the 1955 year-class being poor and the 1957 year-class being represented in extremely small numbers as well.

The average lengths and weights of both spring and autumn spawning herring, for the last three years, are shown in Table 85.

L. Rannak, E. Ojaveer

Table 85. The average lengths and weights of herring in the north-eastern part of the Gulf of Riga

Spring herring (from Cacuam catches)

	Average length (cm)					Average weight (g)				
Age	2	3	4	5	6	2	3	4	5	6
Year 1958	10.2	13.3	15.2	16.7	—	10.2	21.4	30.2	44.5	59.5
1959	11.4	13.8	16.4	18.1	—	12.5	21.2	41.3	55.0	70.5
1960	11.3	13.0	16.0	17.3	—	13.5	19.6	37.3	44.5	68.2

Autumn herring (from fixed net catches)

	Average length (cm)								Average weight (g)							
Age	3	4	5	6	7	8	9	10 and over	3	4	5	6	7	8	9	10 and over
Year 1958	15.6	16.2	17.1	17.8	18.0	18.5	19.0	19.4	37.8	40.2	48.5	55.7	57.2	60.4	68.4	79.0
1959	15.8	16.0	16.9	17.8	18.5	19.4	19.4	19.6	35.8	39.0	45.0	53.7	63.8	71.8	86.6	77.1
1960	15.3	16.2	16.8	17.1	18.6	18.9	19.1	20.1	32.3	38.9	43.7	47.9	58.6	63.9	63.8	78.8

Table 86. Length distribution (‰)

cm	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Nos.
Gdansk region	1	6	24	58	104	129	208	137	98	78	66	52	24	9	2	3	1	3,021
Bornholm Basin	—	4	27	53	81	105	141	140	124	113	94	60	45	10	1	1	1	2,248

Table 87. Age distribution (‰)

Age	2	3	4	5	6	7	8	9	10	11	12+	Nos.
Year-class	1959	58	57	56	55	54	53	52	51	50	—	
Gdansk region	26	44	128	30	282	154	109	100	36	40	51	396
Bornholm Basin	—	39	192	46	337	117	71	64	28	33	73	391

Polish Investigations of Baltic Herring in 1960

(Tables 86–87)

The age and length composition of the spring spawning herring during the summer/autumn feeding period are given in Tables 86 and 87.

The most numerous year-classes in both areas were those of 1954, 1955, and 1957.

The catch per fishing day in the summer/autumn season of 1960, when the spring spawning herring predominate in the landings increased in comparison with that in 1959.

The corresponding figures for the years 1956/1960 are the following:—

Year	Gdansk region (kg/fishing day)	Bornholm Basin (kg/fishing day)
1956	478	786
1957	85	688
1958	243	621
1959	278	662
1960	348	802

As in 1957/59, the local stocks of spring spawning coastal herring yielded very low catches.

The length/weight coefficient (maturity stages II—III) in spring spawning herring decreased slightly. In the Gdansk region it dropped from 0.639 in 1959 to 0.638 in 1960 and in the Bornholm Basin from 0.671 in 1959 to 0.648 in 1960.

H. Janko, J. Popiel

Sardine

Sardine

La Sardine de la Côte du Portugal en 1958/1960

(Figure 1; Tableaux 1–2)

La production totale a été de 133.088 tonnes en 1958, de 121.025 en 1959 et de 138.746 en 1960. Les chiffres suivants correspondent aux trois ports où ont été faites les observations:—

	1958	1959	1960
Leixões	77.607	74.329	69.832
Lisbonne	5.302	3.683	2.381
Portimão	6.118	5.628	12.821

A Leixões et Portimão les échantillons ont été recueillis tous les jours de pêche; à Lisbonne ils ont été hebdomadaires. Les observations ont été poursuivies suivant la routine antérieurement établie, mais à Lisbonne on a étudié aussi la coccidiose testiculaire par *Eimeria sardinae* (Thél.).

Taille et âge

A Leixões les sardines de la nouvelle génération (classe 0 d'âge), sont apparues, en 1958, pour la première fois dans le produit de la pêche, au mois de septembre, présentant des tailles modales de 12,5 cm. En 1959 et 1960 les représentants des nouvelles générations sont apparus en juillet, leur taille modale étant de 11,0 et de 9,5 cm respectivement. Pendant la seconde moitié des trois années considérées les sardines plus âgées ont largement prédominé, les tailles modales oscillant entre 16,0 et 17,5 cm; les exemplaires des classes 0 sont toujours peu nombreux dans cette époque, mais d'une façon prèsque régulière, leur nombre augmente à partir d'octobre jusqu'à décembre. L'ensemble des échantillons montre à Leixões, pendant les trois années considérées, une nette prédominance des exemplaires entre 12,0 et 20,0 cm.

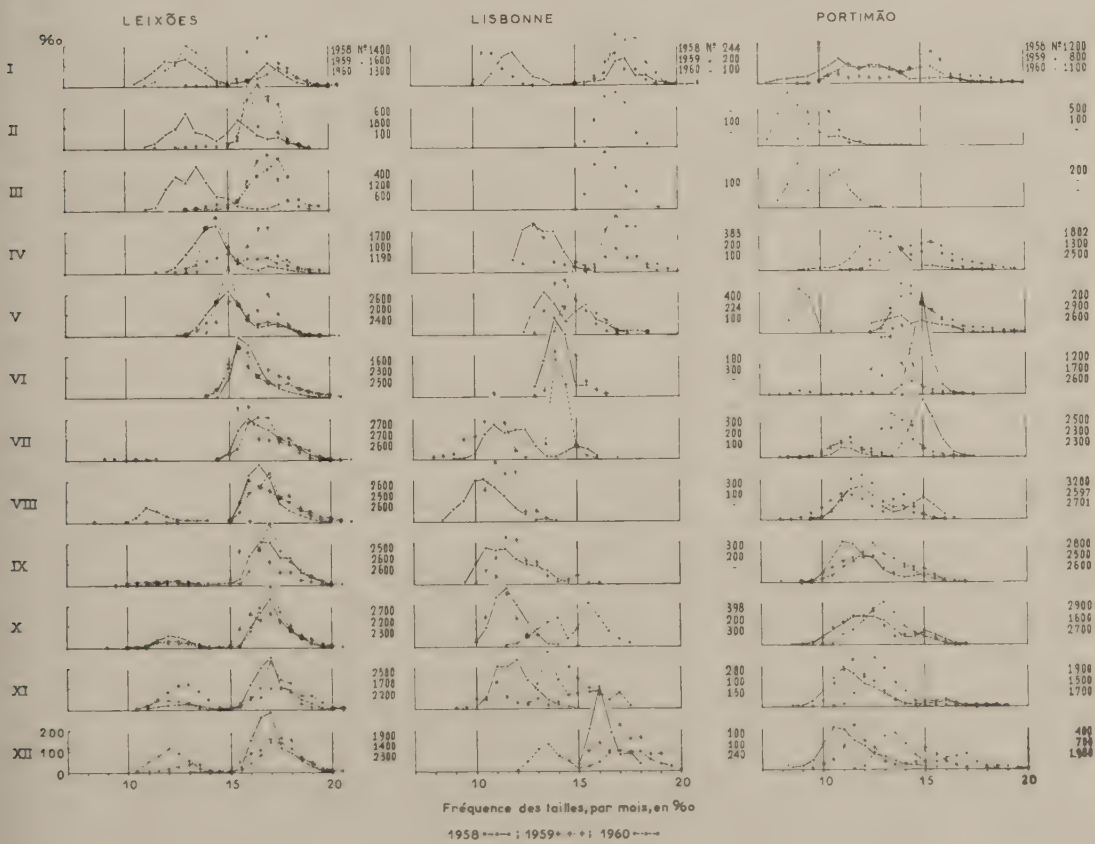


Figure 1.

Tableau 1. Fréquences des tailles (‰) du nombre total (N) d'exemplaires observés chaque mois pendant les années 1958 1960

Leixões – 1958

L	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
8.0	—	—	—	—	—	—	—	—	—	—	—	—
.5	—	—	—	—	—	—	—	—	—	—	—	—
9.0	—	—	—	—	—	—	—	—	—	—	—	—
.5	—	—	—	—	—	—	—	—	—	—	—	—
10.0	—	—	—	—	—	—	—	—	—	—	—	—
.5	7	—	—	—	—	—	—	—	—	—	—	—
11.0	30	7	5	—	—	—	—	—	2	8	8	—
.5	69	27	15	—	—	—	—	—	6	39	15	—
12.0	113	63	100	3	—	—	—	—	15	54	28	1
.5	110	85	165	14	1	—	—	—	20	52	28	—
13.0	126	160	135	76	8	—	—	—	16	30	31	1
.5	99	73	217	148	27	—	—	—	6	16	16	1
14.0	61	66	135	221	103	—	—	—	—	2	6	2
.5	28	32	75	227	166	8	3	—	—	—	1	—
15.0	14	62	67	121	218	98	35	10	4	—	1	1
.5	19	121	22	64	153	291	144	87	24	12	15	20
16.0	19	103	13	24	88	264	207	227	138	91	112	140
.5	52	60	8	11	39	163	173	278	206	165	198	262
17.0	106	45	13	33	57	75	148	214	205	229	244	288
.5	76	55	30	29	62	44	102	83	124	127	117	110
18.0	44	27	—	19	47	29	91	51	121	77	91	88
.5	16	12	—	5	19	18	56	31	60	53	49	43
19.0	5	2	—	2	8	6	27	11	36	33	26	26
.5	4	—	—	2	2	4	10	6	12	9	9	9
20.0	2	—	—	1	1	—	2	1	4	3	4	2
.5	—	—	—	—	1	—	1	—	1	—	1	—
21.0	—	—	—	—	—	—	1	1	—	—	—	—
N	1.400	600	400	1.700	2.600	1.600	2.700	2.600	2.500	2.700	2.500	1.900

L = taille em cm; N = nombre d'exemplaires.

Leixões – 1959

L	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
8.0	—	—	—	—	—	—	—	—	—	—	—	—
.5	—	—	—	—	—	—	—	1	—	—	—	—
9.0	—	—	—	—	—	—	—	—	—	1	—	—
.5	—	—	—	—	—	—	—	—	1	—	—	—
10.0	—	—	—	—	—	—	1	—	1	2	—	—
.5	—	—	—	—	—	—	2	—	12	4	1	2
11.0	—	—	—	—	—	—	9	1	7	6	10	9
.5	—	1	—	—	—	—	7	—	13	25	49	10
12.0	—	—	—	—	—	—	—	1	11	18	79	16
.5	—	3	—	—	—	—	—	2	6	24	112	26
13.0	9	5	1	2	1	—	—	—	2	27	114	39
.5	5	10	6	12	—	—	—	—	—	17	86	38
14.0	5	13	20	60	11	1	—	—	—	5	49	9
.5	8	7	27	77	62	21	1	—	—	2	9	7
15.0	8	8	27	92	168	158	45	12	24	15	13	14
.5	32	53	40	54	160	237	251	98	156	89	25	44
16.0	168	234	145	127	98	137	253	210	304	168	58	96
.5	237	304	241	216	120	91	110	166	167	124	55	104
17.0	244	237	272	225	199	127	98	152	118	165	107	155
.5	116	74	151	84	106	90	90	115	61	121	106	164
18.0	82	33	46	32	48	92	80	130	61	103	82	153
.5	42	12	19	12	19	27	31	63	27	51	26	72
19.0	26	6	3	7	6	14	15	30	20	19	13	31
.5	9	—	—	—	2	4	3	13	8	8	5	6
20.0	8	—	2	—	—	1	3	4	1	6	—	5
.5	1	—	—	—	—	—	1	2	—	—	1	—
21.0	—	—	—	—	—	—	—	—	—	—	—	—
N	1.600	1.800	1.200	1.000	2.000	2.300	2.700	2.500	2.600	2.200	1.700	1.400

Leixões – 1960

L	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
8.0	—	—	—	—	—	—	—	—	—	—	—	—
.5	—	—	—	—	—	—	—	—	—	—	—	—
9.0	—	—	—	—	—	—	2	—	—	—	—	—
.5	—	—	—	—	—	—	2	—	—	—	—	—
10.0	—	—	—	—	—	—	—	2	3	1	—	—
.5	—	—	—	—	—	—	1	11	6	3	11	7
11.0	4	—	—	—	—	—	—	62	17	9	23	42
.5	19	—	—	3	—	—	—	50	18	27	50	74
12.0	72	—	—	—	—	—	—	15	16	29	44	109
.5	105	—	—	6	—	—	—	5	16	32	41	86
13.0	197	—	2	19	2	—	—	5	7	28	32	53
.5	162	—	5	29	13	—	—	3	6	6	9	9
14.0	82	—	5	214	50	4	—	2	5	2	5	3
.5	13	—	2	261	165	21	1	—	4	1	8	6
15.0	4	20	10	114	319	138	28	2	3	3	5	2
.5	14	30	35	45	158	241	50	33	4	6	5	3
16.0	24	330	107	66	78	220	178	130	55	70	37	29
.5	35	100	161	61	46	98	204	156	163	183	95	75
17.0	53	240	190	71	50	76	205	225	283	290	227	141
.5	83	210	250	41	47	55	108	110	152	160	141	139
18.0	69	40	160	53	40	66	102	91	103	74	123	110
.5	34	30	45	12	20	40	54	44	65	37	59	54
19.0	19	—	18	4	11	24	45	33	47	26	63	40
.5	8	—	10	1	1	10	16	16	24	9	15	14
20.0	2	—	—	—	—	6	3	4	3	3	4	3
.5	1	—	—	—	—	1	1	1	—	1	3	1
21.0	—	—	—	—	—	—	—	—	—	—	—	—
N	1.300	100	600	1.190	2.400	2.500	2.600	2.600	2.600	2.300	2.200	2.300

Lisbonne – 1958

L	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
8.0	—	—	—	—	—	—	—	—	—	—	—	—
.5	—	—	—	—	—	—	—	9	—	—	—	—
9.0	—	—	—	—	—	—	9	58	—	—	—	—
.5	—	—	—	—	—	—	7	100	13	—	—	—
10.0	—	—	—	—	—	—	27	197	90	17	5	—
.5	8	—	—	—	—	—	127	207	173	81	55	—
11.0	53	—	—	—	—	—	173	170	163	234	205	—
.5	136	—	—	—	—	—	127	123	167	279	205	—
12.0	164	—	—	57	—	—	144	67	120	198	235	—
.5	95	—	—	204	15	—	144	40	93	116	130	—
13.0	45	—	—	232	135	40	63	13	87	55	90	—
.5	33	—	—	196	210	170	13	13	67	17	40	—
14.0	4	—	—	191	150	380	13	3	20	3	20	—
.5	4	—	—	94	60	300	33	—	7	—	10	—
15.0	8	—	—	18	108	50	57	—	—	—	5	30
.5	20	—	—	5	142	50	43	—	—	—	—	200
16.0	20	—	—	3	72	—	17	—	—	—	—	410
.5	29	—	—	—	52	10	—	—	—	—	—	180
17.0	115	—	—	—	13	—	3	—	—	—	—	70
.5	128	—	—	—	15	—	—	—	—	—	—	80
18.0	45	—	—	—	15	—	—	—	—	—	—	30
.5	49	—	—	—	10	—	—	—	—	—	—	—
19.0	16	—	—	—	—	—	—	—	—	—	—	—
.5	16	—	—	—	—	—	—	—	—	—	—	—
20.0	4	—	—	—	3	—	—	—	—	—	—	—
.5	4	—	—	—	—	—	—	—	—	—	—	—
21.0	4	—	—	—	—	—	—	—	—	—	—	—
N	244	—	—	383	400	100	300	300	300	398	200	100

Lisbonne – 1959

L	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
8.0	—	—	—	—	—	—	15	—	—	—	—	—
.5	—	—	—	—	—	—	20	—	—	—	—	—
9.0	—	—	—	—	—	—	30	—	—	—	10	—
.5	—	—	—	—	—	—	100	—	—	—	10	—
10.0	15	—	—	—	—	—	105	—	5	20	50	—
.5	165	—	—	—	—	—	180	150	65	135	50	—
11.0	160	—	—	—	—	—	325	290	130	340	130	—
.5	85	—	—	—	—	—	175	230	230	250	60	—
12.0	55	—	—	—	—	—	45	240	215	140	30	—
.5	15	—	—	45	—	—	5	30	115	55	30	—
13.0	5	—	—	245	9	3	—	50	105	55	50	—
.5	—	—	—	165	112	33	—	10	40	—	20	—
14.0	—	—	—	40	245	220	—	—	20	—	30	—
.5	—	—	—	35	267	433	—	—	20	—	210	—
15.0	—	10	10	30	170	197	—	—	45	5	150	—
.5	5	30	80	15	116	70	—	—	5	—	100	90
16.0	45	140	220	20	54	37	—	—	5	—	70	130
.5	105	250	280	70	18	7	—	—	—	—	—	90
17.0	160	270	200	110	9	—	—	—	—	—	—	220
.5	70	220	110	65	—	—	—	—	—	—	—	150
18.0	80	70	90	75	—	—	—	—	—	—	—	160
.5	25	10	—	35	—	—	—	—	—	—	—	80
19.0	10	—	10	35	—	—	—	—	—	—	—	80
.5	—	—	—	10	—	—	—	—	—	—	—	—
20.0	—	—	—	5	—	—	—	—	—	—	—	—
.5	—	—	—	—	—	—	—	—	—	—	—	—
21.0	—	—	—	—	—	—	—	—	—	—	—	—
N	200	100	100	200	224	300	200	100	200	200	100	100

Lisbonne – 1960

L	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
8.0	—	—	—	—	—	—	—	—	—	—	—	—
.5	—	—	—	—	—	—	—	—	—	—	—	—
9.0	—	—	—	—	—	—	—	—	—	—	—	—
.5	—	—	—	—	—	—	—	—	—	—	—	—
10.0	—	—	—	—	—	—	—	—	—	—	—	—
.5	—	—	—	—	—	—	—	—	—	—	—	—
11.0	—	—	—	—	—	—	—	—	—	—	—	—
.5	—	—	—	—	—	—	—	—	—	3	—	—
12.0	—	—	—	—	—	—	—	—	—	13	—	4
.5	—	—	—	—	—	—	—	—	—	53	27	50
13.0	—	—	—	—	—	—	—	—	—	80	120	108
.5	—	—	—	—	—	—	70	—	—	117	273	137
14.0	—	—	—	—	10	—	480	—	—	133	147	79
.5	—	—	—	—	110	—	360	—	—	33	67	50
15.0	10	—	—	—	350	—	60	—	—	83	73	17
.5	—	—	—	10	330	—	20	—	—	204	80	21
16.0	30	—	—	40	100	—	10	—	—	147	80	42
.5	60	—	—	210	70	—	—	—	—	77	40	92
17.0	250	—	—	270	10	—	—	—	—	40	80	100
.5	220	—	—	220	10	—	—	—	—	17	13	87
18.0	230	—	—	220	—	—	—	—	—	—	—	92
.5	110	—	—	20	10	—	—	—	—	—	—	54
19.0	60	—	—	10	—	—	—	—	—	—	—	38
.5	10	—	—	—	—	—	—	—	—	—	—	21
20.0	10	—	—	—	—	—	—	—	—	—	—	4
.5	—	—	—	—	—	—	—	—	—	—	—	—
21.0	10	—	—	—	—	—	—	—	—	—	—	4
N	100	—	—	100	100	—	100	—	—	300	150	240

Portimão – 1958

L	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
7.5	8	32	—	—	—	—	—	—	—	—	—	—
8.0	20	156	40	—	—	—	—	—	1	—		—
.5	28	264	110	—	60	—	—	—	—	1	2	10
9.0	29	206	215	2	215	—	1	—	2	3	3	15
.5	31	110	85	6	175	—	—	2	7	8	27	33
10.0	62	76	75	16	35	—	2	9	43	26	71	108
.5	83	42	155	13	10	—	15	42	117	61	135	200
11.0	122	46	185	21	—	—	50	106	197	100	189	195
.5	85	32	85	57	—	—	48	149	187	132	154	133
12.0	81	16	40	110	—	—	23	159	129	132	110	115
.5	84	8	5	190	45	—	17	118	111	132	95	65
13.0	77	6	5	187	60	—	8	60	59	120	59	60
.5	81	2	—	165	70	2	8	36	32	72	38	35
14.0	48	2	—	97	85	40	64	45	17	37	15	12
.5	22	2	—	46	40	241	171	74	23	36	12	12
15.0	24	—	—	22	60	474	272	103	39	64	17	5
.5	27	—	—	20	50	186	198	68	26	47	21	2
16.0	27	—	—	16	45	43	84	25	9	22	22	—
.5	29	—	—	9	30	10	24	4	—	6	15	—
17.0	17	—	—	9	15	2	12	—	1	1	6	—
.5	7	—	—	7	—	2	3	—	—	—	5	—
18.0	4	—	—	4	—	—	—	—	—	—	2	—
.5	3	—	—	3	5	—	—	—	—	—	2	—
19.0	—	—	—	—	—	—	—	—	—	—	—	—
.5	1	—	—	—	—	—	—	—	—	—	—	—
20.0	—	—	—	—	—	—	—	—		—	—	—
.5	—	—	—	—	—	—	—	—	—	—	—	
21.0	—	—	—	—	—	—	—	—	—	—	—	—
N	1.200	500	200	1.802	200	1.200	2.500	3.200	2.800	2.900	1.900	400

Portimão – 1959

L	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
7.5	—	—	—	—	—	1	—	—	—	—	—	—
8.0	—	—	—	—	—	2	—	1	—	—	—	—
.5	—	—	—	—	—	9	1	3	—	—	—	—
9.0	3	40	—	—	—	24	3	16	2	5	—	—
.5	9	170	—	—	—	18	11	34	15	14	7	7
10.0	14	500	—	—	—	3	13	60	46	36	29	23
.5	45	170	—	—	—	1	50	92	72	88	117	47
11.0	53	80	—	—	—	1	76	128	106	103	177	106
.5	35	20	—	2	—	1	102	127	127	140	229	219
12.0	38	20	—	8	—	—	48	103	128	139	147	136
.5	30	—	—	58	1	4	22	63	129	164	130	108
13.0	28	—	—	154	24	90	22	46	61	93	71	39
.5	31	—	—	168	120	318	143	103	43	44	34	24
14.0	50	—	—	114	238	337	307	123	78	47	19	24
.5	75	—	—	85	224	147	155	68	79	52	11	31
15.0	140	—	—	98	139	35	39	23	63	41	11	100
.5	151	—	—	137	113	6	4	9	38	23	9	71
16.0	118	—	—	85	68	1	2	1	10	8	5	34
.5	42	—	—	52	36	1	2	—	1	3	3	19
17.0	38	—	—	18	17	—	—	—	2	—	—	10
.5	38	—	—	8	8	1	—	—	—	—	1	—
18.0	38	—	—	8	5	—	—	—	—	—	—	1
.5	19	—	—	5	4	—	—	—	—	—	—	1
19.0	4		—		2	—	—	—	—	—	—	—
.5	1	—	—	—	1	—	—		—	—	—	—
20.0		—	—	—	—	—	—	—	—	—	—	—
.5	—	—	—	—	—	—	—	—	—	—	—	—
21.0	—	—	—	—	—	—	—	—	—	—	—	—
N	800	100	—	1.300	2.900	1.700	2.300	2.597	2.500	1.600	1.500	700

Portimão – 1960

L	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
7.5	—	—	—	—	—	—	—	—	—	—	—	—
8.0	—	—	—	—		—	1	—	—	—	—	—
.5	—	—	—	—		—	2		—		—	—
9.0	—		—	—	—	—	6		1	—	—	—
.5	—	—	—	—	—	—	10	1	7	—		—
10.0	19	—	—	—	—	—	27	5	14	2		—
.5	48	—	—	—	—	—	53	47	35	6	1	—
11.0	68	—	—	2	—	—	63	96	73	55	11	—
.5	105	—	—	4	—	—	68	196	110	77	65	2
12.0	78	—	—	8	—	14	35	218	140	121	151	15
.5	95	—	—	22	1	118	44	177	192	174	239	76
13.0	87	—	—	49	22	279	136	82	138	202	186	158
.5	66	—	—	86	93	286	213	61	117	159	119	179
14.0	47	—	—	104	177	150	178	64	78	85	78	122
.5	74	—	—	115	190	68	80	31	56	58	29	72
15.0	77	—	—	131	141	43	46	14	26	39	20	39
.5	88	—	—	134	110	27	23	6	12	16	22	40
16.0	56	—	—	117	79	12	7	2	1	5	25	60
.5	27	—	—	80	64	2	6	—	—	1	19	70
17.0	26	—	—	50	32	1	2	—	—	—	19	73
.5	14	—	—	36	28	—	—	—	—	—	8	33
18.0	7	—	—	30	28	—	—	—	—	—	5	17
.5	14	—	—	19	19	—	—	—	—	—	2	18
19.0	2	—	—	10	10	—	—	—	—	—	1	17
.5	1	—	—	3	5	—	—	—	—	—	—	8
20.0	1	—	—	—	1	—	—	—	—	—		1
.5	—	—	—	—	—	—	—	—	—	—	—	—
21.0	—	—	—	—	—	—	—	—	—	—	—	—
N	1.100	—	—	2.500	2.600	2.600	2.300	2.701	2.600	2.700	1.700	1.900

Tableau 2. Poids moyens annuels des sardines de Lisbonne, en 1958-60

	1958			1959			1960		
L	Pt	N	Pm	Pt	N	Pm	Pt	N	Pm
8.0	—	—		10	3	3,3	—		
.5	19	3	6,3	22	4	5,0	—		
9.0	143	20	7,2	48	7	6,9	—		—
.5	314	36	8,7	170	21	8,1	—	—	—
10.0	1040	102	10,2	305	34	9,0	—		
.5	2252	197	11,4	1401	129	10,9	—		
11.0	3846	229	12,9	2922	233	12,5	—	—	—
.5	4532	310	14,6	2582	177	14,6	15	1	15,0
12.0	4864	287	16,9	2014	118	17,1	71	4	17,8
.5	4977	262	19,0	1012	53	19,1	350	16	21,9
13.0	5217	247	21,1	1975	95	20,8	582	24	24,3
.5	5410	227	23,8	1927	79	24,4	1158	42	27,6
14.0	5082	188	27,0	3923	136	28,8	2820	89	31,7
.5	3303	105	31,5	7277	222	32,8	1997	57	35,0
15.0	2784	78	35,7	4680	130	36,0	2610	67	39,0
.5	4060	102	39,8	3264	82	39,8	4296	97	44,3
16.0	3620	81	44,7	4013	93	43,2	3031	62	48,9
.5	2257	47	48,0	4822	103	46,8	2867	57	50,3
17.0	2309	41	56,3	6651	125	53,2	3419	65	52,6
.5	2710	45	60,2	4334	75	57,8	2846	50	56,9
18.0	1310	20	65,5	3900	63	61,9	2795	45	62,1
.5	1183	16	73,9	1485	21	70,7	963	14	68,8
19.0	330	4	82,5	1297	18	72,1	505	7	72,2
.5	372	4	93,0	158	2	79,5	82	1	82,0
20.0	189	2	94,5	86	1	86,0	90	1	90,0
.5	95	1	95,0	—	—	—	—		—
21.0	109	1	109,0	—	—	—	98	1	98,0

L = taille; Pt = poids total; N = nombre d'éxemplaires; Pm = poids moyen.

A Lisbonne, les nouvelles générations de 1958 et 1959 sont apparues en juillet, présentant des tailles modales de 11,0 cm; en 1960, les représentants de la nouvelle génération ne sont apparus qu'en octobre, leur taille modale étant de 14,0 cm.

De juillet à novembre, des trois années considérées, les sardines des nouvelles générations (classes 0) ont largement prédominé présentant des tailles entre 8,0 et 15,0 cm; de décembre à avril les sardines plus âgées (classes I et II), de 15,0 à 20,0 cm ont prédominé; d'avril à juin les représentants des nouvelles classes I qui viennent d'inscrire sur leurs écailles (en mars) le premier anneau d'hiver, ont prédominé.

En considérant l'ensemble des échantillons on a constaté à Lisbonne, en 1958/60, une prédominance générale des tailles entre 10,0 et 17,0 cm.

A Portimão, de janvier à mars (1958), on a observé de nombreux exemplaires présentant des tailles entre 7,5 et 10,0 cm; ils correspondent à une classe 0, produit de pontes ayant eu lieu en 1957, dans une époque qu'on peut fixer à juin-juillet. Au mois de mars ils inscrivent sur les écailles leur premier anneau d'hiver dans un moment ou leur taille varie entre 8,0 et 10,0 cm. Dans les mois ultérieurs ce type de sardine se mélange aux représentants de la nouvelle classe 0, de 1958. Dans l'ensemble, à Portimão les sardines dont la taille oscille entre 10,0 et 15,0 cm ont prédominé.

Poids

On a déterminé à Lisbonne le poids moyen par classe de taille de demi-centimètre. Les résultats obtenus sont semblables à ceux des années antérieures, mais en 1960 on a constaté des irrégularités correspondant aux tailles entre 12,5 et 16,0 cm; cela doit être le résultat du nombre très réduit d'exemplaires examinés pendant cette année.

Maturation sexuelle et ponte

Les observations faites à Lisbonne confirment les résultats obtenus dans les années précedentes; la ponte s'accomplit spécialement en février-mars, mais peut se prolonger jusqu'à la fin de juin.

J. S. Pinto, I. F. Barraca

Sprat

Tagging Experiments on Sprat in Norwegian Waters

As mentioned in the report of 1959 (Ann. Biol., **16**: 226), experiments with internal and external tags were carried out on sprat. In 1960, both these tagging methods were used in different localities on the west coast of Norway.

In the period 9.—17. June 1960, 517 sprat were tagged externally and 400 internally at Eikelandsosen in the Bjørnefjord area. Of these, 6 external and 16 internal tags were recovered on 28. June, nearly at the same place where the fish were tagged.

At Sæbøvågen in Sunnhordland, 250 sprat were tagged externally and 500 internally during the period 24. to 29. June 1960. Two external and 10 internal tags were recovered.

At Øystese in the Hardangerfjord, 1155 sprat were tagged externally during the period 15. to 27. July; 41 of these were later recaptured. In the period 9.—11. August, 191 sprat were tagged in the same locality, but no recaptures have been reported from this experiment.

Of 799 internally tagged sprat in the period 7. to 16. September 1960 at Aksnes in the Hardangerfjord, 41 were recaptured.

The sprat tagged at Eikelandsosen and recaptured there showed no migration. The sprat tagged at Sæbøvågen spread to Ølen, Etne, and Matre in Sunnhordland, and to Jondal, Herand, and Eidfjord in the Hardangerfjord. The distance from Sæbøvågen to Eidfjord is about 70 nautical miles and the sprat travelling this distance had been 55 days at liberty. Of the sprat tagged at Øystese, the recaptures come from Øystese, Framnes, Jondal, Herand, Ålvik, Kvandal, Kinsarvik, Utne, Djønno, Ulvik, and Eidfjord. The recaptures from the taggings at Aksnes come from Kinsarvik, Eidfjord, and Strandebarm, and the fish had been between 10 and 40 days at liberty.

Most of the tags were discovered by people working in the canneries, some tags were found in the catch by the fishermen, and two of the internal tags were spotted in a reduction plant.

Kaare R. Gundersen

The Winter Fishery for Sprat in the Coastal Waters of Niedersachsen in 1959/60

(Tables 3–4)

An intensive investigation on the so-called "Spitzen" fishery was carried out at the Institut für Küsten- und Binnenfischerei during the 1959/1960 fishing season. Although the main purpose of this investigation was to gain further knowledge

Table 3. Length distribution (‰) of sprat from coastal waters of Niedersachsen

Length, cm	1959 Nov.	1959 Dec.	1960 Jan.	1960 Feb.	1960 March	Total
6	—	—	4	15	—	6
7	—	—	68	72	180	72
8	—	—	133	186	425	174
9	—	13	131	63	169	124
10	16	132	227	61	134	178
11	187	207	175	61	77	159
12	591	295	174	60	11	185
13	187	225	70	37	4	79
14	13	128	18	13	—	22
15	6	—	0	1	—	1
Number of specimens	310	227	2,227	569	521	3,854
Number of samples ..	1	3	14	7	7	32

on the stock composition and on the origin of juvenile herring caught along the German coast, considerable attention was also paid to the stock composition of sprat, which forms part of the catch. Furthermore the distribution of sprat in the coastal waters of Niedersachsen was studied, together with changes in fat content in the course of the season (1, 2, 3). For this purpose, 32 random samples amounting to 3,854 specimens were analysed for length and age composition, whereas 98 fat analyses were made from November 1959 to March 1960.

In the season 1959/60, only 58 tons of sprat were landed by the 78 coastal cutters engaged in the winter fishery for juvenile herring and sprat in the coastal waters of Niedersachsen. Although the fishermen took much higher catches of herring in the season 1959/60 than in 1958/59 (2), the sprat catch was only half of that landed in 1958/59 when 100 tons were caught. Lower catches of sprat were also taken by the fishery with larger boats, carried out near Helgoland and on the shipping route (the P line). These catches amounted to 1,563 tons only in the season 1959/60, whereas 6,706 tons were landed in 1958/1959.

The sprat catches in Niedersachsen are composed of fish of different ages. Usually a mixture of age-groups 0 to III occurs on the fishing grounds. The 0-group was predominant off the islands of Baltrum, Langeoog, and Spiekeroog, whereas the older age-groups were more abundant near Helgoland and also in the Ems Estuary.

The monthly length composition is given in Table 3 (compare also Table 21 in (3)). Sprat over 9 cm long appeared to be mature for the first time

Table 4. Fat content of sprat

Month			cm grouping 7.0–9.0	9.5–12.0	12.5–14.5	Total
Dec.	1959	n	5	13	5	23
		$\bar{x}$(%)	8.6	17.3	18.0	15.6
Jan.	1960	n	6	38	13	57
		$\bar{x}$(%)	8.4	13.6	15.5	13.6
Feb.	1960	n	2	6	5	13
		$\bar{x}$(%)	5.4	9.6	15.7	11.3
March	1960	n	—	4	1	5
		$\bar{x}$(%)	—	5.5	12.6	7.0
December/ March		n	13	61	24	98
		$\bar{x}$(%)	8.0	13.5	16.0	13.4

at the end of their second year of life, and most probably those will have spawned some time in March or April. Unfortunately, it was not possible to determine the exact time of spawning, since the fishery already came to an end early in March, so that no further samples could be obtained after that date.

The fat content of sprat steadily decreased in the course of the season. It was higher in the older year-classes. The decrease in fat content from November to March was less pronounced in fish of age-group II (12.5—14.5 cm) than in fish of the two younger age-groups (Table 4).

K. Tiews

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Soviet Investigations in the Baltic

Age distribution in commercial catches, together with the morphological features of the sprat were investigated.

In 1960, the catches consisted mainly of the rich 1955 and 1957 year-classes. In addition, the rich 1959 year-class was represented in comparatively large numbers in the commercial catches taken at the end of the year. Large catches of sprat are expected in the next two years.

I. Veldre

Scombriform Fish

Mackerel

The Mackerel Fishing of the Netherlands in the Year 1960

(Tables 1–3)

As in the two preceding years (1958 and 1959), data concerning catch, length and age were collected; no alterations in the method of collecting were made.

The fishery

Thanks to greater stock density than usual in the area NN in the months January to April, inclusive, combined with a fishery intensity above the normal level in the same area and during the same time, and a good fishery in October in the area NE, the total catch landed was the highest ever, i.e. 21,487 tons (15,720 tons in 1959).

Table 1. Total catch, effort and catch per effort in four fishing areas during 1960

	Total catch in tons				Number of hours fishing, trawler 500 BHP				Catch in kg per 100 hours fishing, trawler 500 BHP			
Month	NN	NE	NW	S	NN	NE	NW	S	NN	NE	NW	S
January	1,404	269	—	—	8,713	3,369	—	—	16,113	7,993	—	—
February	936	184	—	—	11,419	4,339	—	—	8,199	4,242	—	—
March	844	458	—	—	13,609	4,858	—	—	6,203	9,419	—	—
April	1,584	1,712	—	—	8,123	8,117	—	—	19,505	21,097	—	—
May	1,719	1,632	184	135	12,416	6,851	1,602	1,968	13,843	23,816	11,480	6,850
June	330	414	72	187	7,400	3,228	3,069	8,717	4,456	12,829	2,357	2,149
July	—	1,761	544	254	—	4,633	11,996	7,428	—	38,011	4,536	3,415
August	349	551	482	525	5,437	3,816	8,893	16,669	6,414	14,438	5,421	3,149
September	72	770	244	300	761	3,773	1,225	30,819	9,465	20,412	19,911	972
October	381	1,964	—	85	3,510	11,648	—	6,252	10,841	16,858	—	1,366
November	380	323	—	5	4,682	9,260	—	346	8,109	3,487	—	1,507
December	189	245	—	—	7,369	10,897	—	—	2,559	2,245	—	—
Total	8,188	10,283	1,526	1,491	83,439	74,789	28,785	57,199	—	—	—	—

Table 2. Age composition (winter rings) in the four areas, in 3-month periods, 1960

Period	1+	2+	3+	4+	5+	6+	7+	8+	8+	
					Area NN					
1st quarter	—	31	—	2	31	11	11	4	10	
2nd quarter	1	16	4	3	50	8	10	3	5	
3rd quarter	—	—	2	6	31	28	15	13	5	
4th quarter	—	20	6	34	31	7	2	—	—	
Total %	0.4	19.7	2.6	3.7	40.0	12.3	10.5	4.6	6.3	100.1
					Area NE					
1st quarter	—	32	—	2	29	11	11	4	11	
2nd quarter	—	3	3	4	56	13	14	4	6	
3rd quarter	—	—	3	11	53	19	17	5	2	
4th quarter	—	17	8	39	28	6	2	—	—	
Total %	—	12.6	3.4	13.6	40.2	11.9	10.7	3.1	4.6	100.1
					Area NW					
1st quarter	—	—	—	—	—	—	—	—	—	
2nd quarter	—	4	8	3	60	8	10	3	4	
3rd quarter	—	1	8	9	44	21	9	6	2	
4th quarter	—	—	—	—	—	—	—	—	—	
Total %	—	2.5	8.0	6.0	52.0	14.5	9.5	4.5	3.0	100.0
					Area South					
1st quarter	—	—	—	—	—	—	—	—	—	
2nd quarter	—	—	1	5	51	13	17	5	8	
3rd quarter	—	1	23	8	36	18	8	5	1	
4th quarter	—	82	5	7	5	1	—	—	—	
Total %	—	22.2	8.3	6.3	34.4	11.0	10.1	3.7	3.9	99.9

Table 3. Length distribution (%) of the catch in 3-month periods

Length,	NN				NE				NW		S		
cm	1	2	3	4	1	2	3	4	2	3	2	3	4
20	0.2	0.1	—	—	—	—	—	—	0.1	—	—	—	—
21	0.2	0.4	—	—	0.1								
22	0.7	0.4	—	—	0.5								
23	0.8	0.5	—	0.1	0.5	0.1							
24	1.2	0.4	—	—	1.5	—	—	—	0.1	—	—	—	—
25	5.6	3.1	—	0.1	7.6	0.4	—	—	0.5	—	—	—	
26	10.7	6.6	—	0.4	11.9	1.3	—	0.2	1.6	—	—	0.1	1.8
27	6.9	4.0	—	3.0	6.0	1.3	—	1.5	1.1	0.2	0.1	0.6	17.3
28	2.3	1.7	—	4.5	1.7	0.3	0.4	3.2	0.7	0.8	0.2	1.5	17.7
29	0.7	0.6	—	4.3	0.6	0.4	—	4.5	9.9	2.6	0.3	8.6	24.3
30	1.2	1.0	0.7	5.2	0.8	0.7	0.6	4.2	2.4	2.4	0.2	8.5	18.1
31	4.9	6.5	1.7	3.7	4.6	4.5	2.1	3.3	17.0	3.4	2.3	4.1	6.1
32	12.1	17.1	4.4	4.5	11.0	19.8	16.9	7.3	18.8	8.2	11.3	12.5	2.1
33	10.1	14.8	8.8	10.7	8.7	17.0	24.9	14.8	15.7	17.5	15.8	12.5	3.4
34	7.5	8.5	10.5	8.4	6.6	9.9	18.0	13.4	9.6	16.5	15.7	12.4	1.3
35	9.1	8.1	10.1	7.6	9.7	12.2	12.6	11.5	10.3	16.2	12.4	9.4	1.4
36	10.7	8.0	13.5	12.0	13.5	17.1	9.3	10.6	10.6	14.4	17.7	14.2	2.2
37	8.1	7.7	16.4	13.3	8.5	8.8	5.2	9.6	5.9	11.3	12.8	12.3	1.7
38	3.9	5.2	16.8	10.2	2.6	4.3	3.3	5.8	2.0	4.4	5.4	1.8	1.3
39	1.2	2.2	12.5	5.9	2.4	0.9	2.4	3.3	1.8	1.2	3.7	1.2	0.1
40	1.0	1.3	3.8	2.5	0.5	0.6	1.3	2.5	1.4	0.5	1.3	0.1	—
41	0.6	0.8	0.7	1.6	0.4	0.2	1.2	2.6	1.1	0.2	0.6	—	0.1
42	0.2	0.5	0.2	1.2	0.3	0.1	0.9	0.7	0.4	0.2	—	—	1.0
43	0.1	0.2	0.1	0.7	—	—	0.5	0.6	—	0.1	0.1	—	0.2
44	0.1	0.1	—	0.1	—	—	—	0.2	—	—	—	—	—
45	—	—	—	—	—	—	—	0.1	0.1	—	—	—	—
46	—	—	—	—	—			0.1					

The distribution of the fishery intensity and stock density followed the usual pattern in the different areas in course of the year; the total fishery intensity with area fished was about the same as in the preceding years (Table 1). Unusual was the great density in the area NN during the month of July.

Age and length distribution

In 1960 a new good year-class appeared in the catches as 2-ringers; of the remainder of the catches, 30 to 50% were formed by 5-ringers (Table 2); in the years 1958 and 1959, 2-ringers were scarce. In length distribution these 2-ringers appeared as specimens of 24—28 cm length; such lengths were almost absent in 1958 and 1959. The longer (older) animals represented in the areas NN and NE a greater part of the catch than in the areas NW and South (Table 3).

J. J. Zijlstra, K. H. Postuma

Tuna

The German Tuna Fishery in 1960

(Tables 4–6)

In 1960, the German tuna catch was below average and, if referred to the number of tuna caught, the catch was as low as in 1958 when tuna fishing was a failure for the German fishermen. The total catch amounted to 1,623 tunas only. However, the weight of the catch was with 434 tons (= 645,000 DM) higher than in 1958, since, in 1960, the tuna were heavier than in all previous years (Table 4).

Table 4. German tuna catch from 1951 to 1960

Years	Number	Total weight, tons	Average weight, kg
1951	1,120	231	206
1952	1,420	298	210
1953	1,560	307	197
1954	3,100	648	209
1955	4,810	1,068	222
1956	2,306	555	240
1957	5,599	1,286	230
1958	1,625	380	234
1959	3,818	977	254
1960	1,623	434	267

Table 5. Length distribution (‰) of the German tuna catch in 1960

Length, cm	August	September	October	Total
212.5	—	2	—	1
217.5	5	1	3	2
222.5	5	13	13	12
227.5	38	50	55	49
232.5	104	113	168	123
237.5	165	178	240	190
242.5	212	244	223	235
247.5	188	170	152	168
252.5	132	140	75	125
257.5	85	61	42	61
262.5	47	15	23	22
267.5	9	9	6	8
272.5	5	2	—	2
277.5	—	2	—	1
282.5	5	—	—	1
Number of specimens	212	915	309	1,436
Number of total catch	220	1,015	388	1,623

Table 4 shows that German tuna catches fluctuate considerably from year to year. RODEWALD (1960), investigating the period from 1954 to 1959, pointed out that the German catches of big tuna in the North Sea during the season August to October and the corresponding Norwegian catches taken in July off south-western Norway, seem to depend on the anomalies of the atmospheric circulation along the migration route of the tuna from June to August/September.

He found that, in years of good catches, the atmospheric circulation favours the inflow of Atlantic water masses into the northern North Sea, while in years of poor catches it is adversely directed. During the years under observation, favourable winds coincided with averagely higher temperatures of the surface waters, which the migrating tuna traversed in June and July.

However, it is difficult to decide on which of these factors, wind or temperature, the migration of tunas depends the more. The result obtained in 1960, gives to an certain extent an answer to this question. Here, poor catches coincide with unfavourable conditions of the atmospheric circulation, but not with temperatures being below average. On the contrary, in 1960, the temperature was above the average. Although these results have to be considered very preliminary since only few years are under investigation, the atmospheric circulation may be more responsible than could previously be shown (1) for the early arrival of big tuna in the North Sea, on which the success of the German tuna fishery so widely depends.

The length measurements show that the average

Table 6. Average length, weight, and feeding coefficient (K)

	n	$\bar{x}$ in cm	$\bar{x}$ in kg	K
August	212	244.910	262	1.784
September	915	242.660	269	1.882
October	309	241.205	267	1.903
Total	1,436	243.105	267	1.858

fork length has further increased, in comparison with previous years. The average length amounted to 243.105 cm (1959 = 239.930 cm) and the average weight to 267 kg. Similar to previous years, the feeding coefficient is rapidly increasing from August to October. The weight refers to gutted fish, but with head and gills (Table 6).

K. TIEWS

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The Norwegian Tuna Investigations, 1960

(Figure 1; Tables 7–11)

The weight frequency distribution

In 1960, the Norwegian total catch of bluefin tuna amounted to 22,381 fish or 3,265,008 kg. Compared with 1959, it means an increase in the yield of 5,844 fish or 772,642 kg. Tables 7—9 show the weight distribution of the tuna landed in the different districts. In Table 10 are given some data showing the condition factor (K) of tuna landed in district VI in 1959 and 1960. The condition factor is defined by the formula:

$$K = 10^5 \frac{w}{l^3}$$

where l is the fork length and w the weight of ungutted tuna. Collection of the statistical data, and grouping of the material has been made in the same way as for the previous years (HAMRE, 1960). Figure 1 shows the weight-frequency curves of the tuna landings by districts. Corresponding curves for 1958 and 1959 are included for comparison. The columns to the left illustrate the number of fish caught.

Concerning the tuna influx to the northern fishing

Table 7. Weight frequency distribution (‰) of Norwegian caught tuna, for districts II, III, IV

Total catch district II and III: 1,674 fish; total catch district IV: 194 fish

Group mean, kg	District II Weeks 31–32	District III Weeks 29–32	District III Weeks 33–37	Total	District IV Week No. 32
82 ...	—	1	—	1	5
87 ...	—	—	—	—	5
92 ...	—	—	—	—	11
97 ...	—	—	—	—	—
102 ...	—	—	—	—	5
107 ...	—	—	—	—	5
112 ...	—	—	—	—	—
117 ...	7	2	2	3	5
122 ...	10	1	5	4	11
127 ...	—	4	—	2	5
132 ...	10	7	9	8	70
137 ...	3	19	2	12	43
142 ...	21	20	11	18	32
147 ...	28	14	23	19	48
152 ...	31	31	25	29	48
157 ...	52	44	18	38	37
162 ...	48	45	48	47	64
167 ...	72	57	39	55	70
172 ...	89	60	36	59	86
177 ...	69	101	57	83	48
182 ...	96	90	64	84	86
187 ...	55	69	91	73	37
192 ...	72	83	77	80	75
197 ...	76	68	50	64	54
202 ...	65	58	73	64	48
207 ...	41	54	66	55	37
212 ...	38	45	55	47	5
217 ...	21	23	50	30	27
222 ...	34	30	41	34	21
227 ...	14	20	27	21	—
232 ...	10	20	34	22	—
237 ...	14	13	32	19	—
242 ...	7	4	23	10	5
247 ...	3	7	21	10	—
252 ...	3	5	9	6	5
257 ...	7	1	7	4	—
262 ...	—	1	—	1	—
267 ...	—	—	5	1	—
272 ...	—	1	—	1	—
277 ...	—	—	—	—	—
282 ...	—	—	—	—	—
287 ...	—	—	—	—	—
292 ...	—	—	—	—	—
297 ...	3	—	—	1	—
n ...	291	840	440	1,571	187

area (districts I—III), it seems fair to regard these tuna schools as belonging to the same contingent of tuna which occurred in the North during the 1959 season. This contingent has been dominated by the year-class 1947, and the very small catch of tuna of this size during the two last years argues that the strong 1947 year-class of tuna is now nearly exhausted.

The weight composition patterns of the tuna

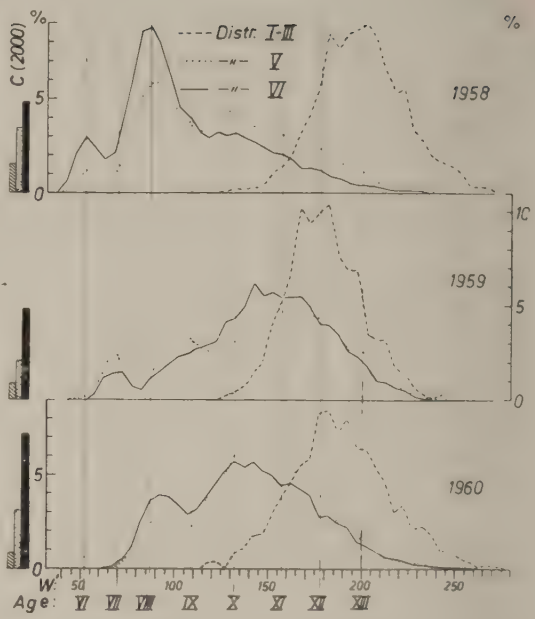

Figure 1. Weight composition (w' = commercial weight in kg) of Norwegian tuna landings by districts, 1958–60. The columns illustrate number of fish caught in districts I–III (shaded), district V (dotted), and district VI (black.)

landings in districts V and VI (Fig. 1.) show that the 1950 year-class is still the strongest in the adult tuna stock. These frequency curves corroborate the conclusion that the apparent low relative strength of the 1950 year-class in 1959, was due to the prevailing fishing conditions (Hamre, 1961). As in previous years, the contingent of tuna dominated by the 1950 year-class, contains considerable quantities of tuna of the 1949 and 1952 year-classes. Attention may be drawn to the fact that no strong year-classes younger than that of 1952 have appeared in the Norwegian tuna catches. Bearing in mind that a strong year-class may appear already as 5 year-old fish, the prospects of the tuna fishery in the years to come are not promising.

The contingent of tuna, dominated by the 1950 year-class, has partly followed the second migration pattern along the Norwegian coast (Hamre, 1961). The tuna arrived in the northern part of district V, migrating southward, and after two weeks the main fishery was carried on in the northern part of district VI. In that area the tuna schools remained for the rest of the season, an incident which certainly prolonged the tuna fishery on the Norwegian

Table 8. Weight frequency distribution (‰) of Norwegian caught tuna, for district V in 1960; total catch 6,234 fish

Group mean (kg)	Week numbers 30	31	32	33	34	35	36	37	38	39	40	41	Total
62	—	1	—	—	—	—	—	—	—	—	—	—	—
67	—	1	—	—	—	—	—	—	2	—	—	—	1
72	—	4	—	—	—	2	3	24	6	2	—	—	3
77	—	11	6	—	26	7	10	24	14	5	2	—	9
82	—	11	11	—	17	4	8	28	48	25	5	8	18
87	—	10	11	—	35	6	36	60	62	36	11	—	25
92	—	10	4	—	43	11	29	52	66	39	5	4	24
97	—	9	6	—	26	18	21	56	52	43	14	—	23
102	—	10	9	—	—	17	18	36	52	45	14	8	22
107	—	9	14	—	35	15	36	28	44	39	18	—	22
112	—	24	9	—	9	29	26	44	38	39	16	13	25
117	—	32	28	13	9	33	39	36	57	63	36	—	37
122	—	41	24	13	35	46	42	60	54	72	36	4	42
127	91	50	24	26	60	53	73	84	52	88	36	25	50
132	91	69	34	39	69	75	81	68	58	77	63	17	61
137	91	60	55	64	78	62	62	44	56	61	43	55	57
142	91	63	67	26	78	75	86	48	40	77	59	38	61
147	46	83	58	26	69	44	73	48	38	59	68	42	59
152	136	76	60	64	52	61	65	36	41	50	68	84	61
157	—	66	66	51	69	70	31	20	34	36	59	51	53
162	46	55	73	115	78	40	39	24	32	48	79	80	54
167	46	58	62	115	26	62	47	20	34	23	47	72	50
172	91	48	62	51	60	51	31	40	14	18	81	63	44
177	91	43	49	103	17	53	44	36	21	20	45	46	40
182	46	43	51	90	43	48	16	32	19	9	52	89	39
187	—	28	34	13	17	24	23	20	17	11	32	30	24
192	46	28	40	77	17	29	18	4	11	7	36	46	26
197	—	14	32	39	9	17	10	8	8	5	23	68	18
202	—	15	32	13	9	17	13	—	7	5	18	21	15
207	—	11	30	26	—	2	5	12	5	—	14	34	12
212	—	6	10	—	—	7	5	4	6	—	7	30	7
217	46	5	15	13	—	4	—	4	5	—	5	21	7
222	—	2	3	—	9	6	5	4	3	—	7	13	4
227	46	2	3	—	—	6	—	—	2	—	5	8	3
232	—	1	7	13	—	4	5	—	2	—	2	21	4
237	—	—	3	—	—	—	—	—	—	—	—	—	1
242	—	1	2	—	—	2	—	—	2	—	—	4	1
247	—	—	2	—	—	—	—	—	1	—	—	4	1
252	—	1	—	13	9	—	—	—	—	—	—	—	1
257	—	—	1	—	—	—	—	—	—	—	—	—	—
262	—	—	2	—	—	2	—	—	—	—	—	—	1
n	22	1,341	915	78	116	545	385	251	1,035	442	444	237	5,810

west coast in 1960. Concerning the reasons for this unusual situation, it was borne out from echo records that the concentrations of food organisms (herring and mackerel) were more dense in the northern than in the southern part of district VI during the tuna season. The hydrographical observations show no differences between the two areas, and it seems fair to conclude that the difference in the food conditions was the main reason why not a single tuna was caught in the southern part of district VI in 1960. This incident has unveiled a new factor in the environmental conditions which may influence the migration of the tuna along the Norwegian west coast. The stop in the southward migration of the tuna schools has most probably increased the yield of the Norwegian tuna fishery. It is, however, evident that this situation may have had the opposite effect for the tuna fishery in the North Sea.

Table 10. Average length, weight, and condition factor of tuna landed to district VI in 1959 and 1960

	Week	n	l	w	w'	*K*
	31	25	221	215	167	1.99
1959	33	25	221	212	165	1.96
	34	30	214	180	140	1.84
	36	25	167	88	68	1.89
1960	36	50	198	149	116	1.92
	39	30	189	137	106	2.03

Table 9. Weight frequency distribution (‰) of Norwegian caught tuna, for district VI in 1960; total catch: 14,270 fish

Group mean (kg)	Week numbers 30	31	32	33	34	35	36	37	38	39	40	41	42	Total
27	—	—	—	—	—	—	—		—	2	—	—	—	—
32	—	—	—	—	—	—	—	—	—	—	—	—	—	—
37	—	—	—	—	—	—	—	—	—	—	—	—	—	—
42	—	—	—	—	—	—	—	—	1	2	—	—	—	—
47	—	—	—	—	—	—	—	—	1	1	—	—	—	—
52	—	—	—	—	—	—	—	1	1	2	—	—	—	—
57	—	—	—	—	—	—	—	1	1	1	—	—	—	—
62	—	—	—	—	—	—	—	2	1	2	—	—	18	1
67	—	—	—	1	1	1	1	5	1	1	—	—	—	1
72	—	—	26	5	3	2	7	9	5	8	4		—	5
77	—	18	—	10	10	4	13	30	12	16	8	5	—	12
82	—	11	—	21	18	18	26	60	27	29	24	12	—	26
87	—	25	79	16	20	15	32	93	48	64	44	18	18	37
92	—	21	26	17	29	23	43	72	44	85	44	21	18	40
97	—	21	26	16	20	21	37	67	45	76	44	67	18	39
102	—	11	26	16	20	22	35	53	40	53	28	67	18	34
107	—	11	—	10	14	24	29	54	36	49	40	32	18	30
112	—	21	26	15	14	32	35	47	37	39	24	30	18	32
117	—	21	26	28	30	36	42	48	41	43	44	37	18	38
122	—	70	105	26	41	46	51	54	45	46	40	27	55	45
127	27	42	53	48	56	50	57	73	50	55	48	9	73	52
132	27	67	—	70	53	69	57	55	56	52	48	18	55	57
137	108	60	26	53	70	53	66	45	52	44	44	43	18	54
142	54	39	79	66	62	57	60	57	55	66	40	27	109	57
147	27	53	26	68	69	52	59	28	50	42	61	46	55	52
152	54	60	79	67	69	59	47	28	44	34	32	51	91	50
157	54	91	53	56	61	48	48	23	39	29	48	36	18	44
162	162	67	53	58	79	52	43	16	36	29	40	62	55	46
167	54	49	79	56	43	53	41	25	36	27	36	67	55	43
172	108	39	—	62	38	49	31	23	38	24	24	62	36	39
177	54	32	79	43	30	33	28	7	23	21	40	41	91	28
182	—	25	—	37	36	40	30	6	22	11	44	39	55	28
187	54	18	—	29	34	31	23	7	22	9	28	41	18	24
192	27	42	53	48	27	26	16	4	19	9	16	36	36	22
197	27	21	53	17	14	21	13	4	11	12	16	27	18	15
202	54	28	—	13	16	18	8	2	12	5	12	18	—	12
207	54	4	—	9	6	16	7	—	11	4	4	25	—	10
212	27	14	—	9	6	9	3	1	8	3	16	11	18	7
217	—	11	—	—	5	6	6	2	8	—	—	9	—	5
222	27	—	—	10	4	6	1	—	5	2	24	4	—	4
227	—	7	—	3	3	3	1	—	5	2	4	2	—	3
232	—	—	—	—	—	2	1	—	7	—	4	5	—	2
237	—	4	26	—	—	2	1	1	2	—	12	2	—	2
242	—	—	—	—	2	2	—	—	2	2	—	—	—	1
247	—	4	—	—	1	1	—	—	2	—	—	2	—	1
252	—	—	—	—	—	1	—	—	1	—	—	2	—	1
257	—	—	—	—	—	—	—	—	1	—	8	2	—	—
262	—	—	—	—	—	—	—	—	1	—	—	—	—	—
277	—	—	—	—	—	—	—	—	1	—	—	—	—	—
n	37	285	38	1,123	1,252	2,931	2,266	1,280	3,192	969	248	564	55	14,240

Table 11. Release and recovery data for tagged tuna

Release		Recapture		Days at	Weight
Date	Locality	Date	Locality	liberty	in kg (w)
Sept. 8. 1959	N 59°44′, E 4°51′	Sept. 19. 1960	N 61°02′, E 4°20′	377	113
Aug. 8. 1960	N 60°47′, E 4°15′	Aug. 17. 1960	N 60°39′, E 4°20′	9	231
Sept. 1. 1959	N 59°55′, E 4°55′	Aug. 1. 1960	N 61°52′, E 4°35′	335	102
Aug. 21. 1959	N 59°40′, E 4°55′	May 20. 1960	Cadiz, Spain	273	217

Tagging experiments

During the 1960 season, 62 tunas were tagged and released in the fishing localities in districts V and VI by the same tagging method as in 1959. In 1960, 4 recaptured Norwegian tuna tags were reported (Table 11).

JOHS. HAMRE

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Salmon and Trout

England and Wales

River Axe Salmon and Sea-Trout Investigations

During 1960 the trapping installation on the River Axe, Devon, was in operation during all but 24 days in the year when, owing to an exceptionally wet autumn, very severe flooding rendered the installation inoperable. The count of salmon and sea trout moving up and down the river during the year is, therefore, not a complete one and the indications are, from the proportions of tagged to untagged kelts of the two species now being caught, that there was a considerable escapement during the times when the trap was no longer a barrier to fish and the valley was flooded from one side to the other. However, in spite of these unusually severe conditions the installation suffered no damage sufficient to put it out of action and a number of major floods, and all minor ones, have been fished successfully.

(a) Salmon

During the early months of the year, 160 salmon kelts of the 1959 run were tagged with Lea hydrostatic tags. Two of these fish reappeared in the 1960 spawning run. The arrival of kelts at the trap was usually coincident with higher than normal water levels (although the rise was often only a matter of a few inches) and they appeared to travel equally by night and by day.

The grid-trap for descending fish was adapted to catch smolts this year and 2,029 salmon smolts were tagged, some of them by Norwegian and Swedish tagging teams. The modal value of the salmon smolt lengths (nose to fork of tail) was 15 cm and a very high proportion of these were in the 1+ age-group.

Up to the end of the year, 285 salmon were trapped moving upstream. These fish were tagged with plastic flag tags of distinguishing colours for each month in an attempt to observe their spatial and chronological distribution in the watershed. The extremely unfavourable water conditions in the latter part of the year, however, thwarted this attempt, and it is being repeated in 1961.

The sex ratio of the 1960 observed spawning run was one cock fish to 1.5 hen fish. It appeared that there was no difference in the migration time of the two sexes.

Analyses of the numbers of salmon ascending into the trap during the hours of daylight and darkness indicates that during most months, and especially in the first half of the year, there was a greater tendency for them to enter during the hours of darkness. As the spawning time approaches this tendency may no longer be evident and, in fact, in November 1959, after the fish had not run up the river for some months owing to low water conditions the tendency to run at night was reversed, far more fish coming through the trap during daylights hours. An analysis of the effects of other factors such as water levels, water temperatures, and tidal conditions is in progress.

(b) Sea Trout

During the winter of 1959/60, 324 adult sea-trout kelts and 110 sea-trout whitling (less than one year in the sea) were caught descending the river and were tagged with Lea hydrostatic tags before release. Of these 434 sea trout, 52 were recaptured at the trap in the 1960 spawning run and 13 were caught by anglers or netsmen in other rivers or on the coast; noteworthy amongst these are, first, the sea trout recaptured ascending the River Tweed in Scotland (Nature, Lond., **187** (4740), 1960) 266 days after liberation from the trap as a kelt on the Axe and after a minimum journey of 580 miles; secondly, the sea trout caught in the River Taw, North Devon, after a minimum journey of 244 miles in 174 days.

Recently, another long-distance recapture of a sea trout has been made. The fish was tagged at the trap as a kelt in January 1961 and recaptured 36 days later in St. Mary's Bay, Kent, after moving a minimum distance of 200 miles.

During the spring 2,032 sea-trout smolts were tagged at the trap and 97 of these have returned as whitling (= less than one year in the sea) in the 1960 spawning run. Three others have been caught in other rivers or on the coast.

The average length (nose to fork of tail) of the smolts decreased during the run, was 22.1 cm in March and 20.5 cm in April.

By the end of the year 2,933 sea trout had been trapped ascending the river. Of this total approximately half were adult fish and half were whitling, of which only a proportion spawn. The early run during April and May was composed almost entirely of adult sea trout, some of them up to about sixteen pounds in weight. The later run during July and August was very largely composed of whitling.

I. R. H. Allan, A. Swain, M. J. Bulleid

International Salmon Smolt Tagging Experiment

(Tables 1–2)

The comparative tagging tests on salmon smolts begun in 1959 were continued in the spring of 1960. This year Norwegian and Swedish teams came over to this country to tag, and experiments were made to compare the performance of smolt tags used by these teams and English teams at:—

A. The salmon trapping installation on the River Axe at Colyford, East Devon.

B. In the Llanthony Weir branch of the River Severn at Gloucester.

A. *On the River Axe* the descending smolts were collected in a water-filled channel on the downstream side of the grid trap from which they were transferred by fine-meshed hand nets to the tagging tables. Before the arrival of the Scandinavian tagging teams, some of the smolts arriving in the trap were stored in floating wooden cages and these fish were probably not in such good condition as those which were tagged as they arrived in the trap.

The techniques used by the various tagging teams were the same as reported last year. Everyone used serially numbered tags. The Norwegian and Swedish teams anaesthetized their fish with urethane before tagging but the English team did not use anaesthetics.

Table 1. Details of salmon smolts tagged at Colyford at the end of April 1960

Team	Type of tag	Numbers of fish tagged
Norwegian .	Lea hydrostatic (yellow and blue)	409
Swedish ...	Carlin tag with English text (light blue)	470
English	Silver plate (blackened)	460
	Total	1,339

B. *On the River Severn* the salmon smolts were caught by means of an eel net. Each wing of this funnel-shaped net was secured by rope to the corresponding bank. The net was dependant on a good flow of water for carrying the smolts into the throat and from there into the tapering 'cod-end' fitted with two or three non-return valves. At frequent intervals the smolts were transferred from the cod-end to water-filled boxes. The English team tagged the smolts in these boxes but for the Scandinavian teams the fish were transferred to tagging positions on the bank. The tagging techniques were as previously reported except that the English team did not here measure the fish.

Table 2. Details of salmon smolts tagged at Gloucester between 22. and 25. April 1960

Team	Type of tag	Numbers of smolts tagged
Norwegian .	Lea hydrostatic	658
Swedish ...	Carlin tag with English text	680
English ...	Silver plate (blackened)	835
	Total	2,173

A Swedish tag fixed to a salmon smolt in the River Severn at Gloucester on 23. April 1960, was found unattached on the top of Steep Holm, an island in the Bristol Channel, near Weston-super-Mare. The tag was found on 29. June and had obviously been transported by a bird.

Tests of Scottish and English tags, Colyford, East Devon, 1960

The experiment made to compare Scottish and English tags at Colyford was abandoned owing to lack of smolts after 8 wild and 100 hatchery bred smolts had been tagged by the Scottish technique and 8 wild and 84 hatchery bred smolts had been tagged by the English technique.

A. Swain, I. R. H. Allan

Rivers Usk, Wye, and Severn Smolt Tagging Experiment

The experiments begun in 1958 to obtain information as to the origins of the salmon caught by commercial nets operating in the lower reaches of the three estuaries, were continued in the spring of 1960. As in 1959, the fixed eel net method of catching the smolts was employed on all three rivers.

On the Severn and the Wye, the same sites as were used in 1959 were used again. On the Usk, however, a different site at Llanellen Bridge, near Abergavenny, was used.

The Usk and the Wye sites were non-tidal but both Severn sites were partially influenced by the tide.

On all three rivers, netting commenced earlier in the season than it did in 1959. On the Wye, fishing began on 8. March but no smolts were caught on that occasion. However, one week later, 304 were caught and tagged in one night. By the time the river flooded during the first week in April, nearly 800 fish had been tagged. After the flood smolts were caught regularly and often in quite large numbers until the 16. May. Only about half a dozen were caught during the following week and the netting ended on 24. May.

On the Severn, netting also began on 8. March but for a few days regular netting was not possible because of high water. A flood occurred during the first four or five days in April and by that time only 12 smolts had been caught and tagged. However, when fishing was resumed on 6. April, appreciable numbers of smolts were caught each day; at Tewkesbury during the first half of April and at Gloucester during the second half of the month.

The netting on the Severn ended on 3. May, not because the smolt run had ended but because the target of 5,000 had been exceeded; also the smolts caught during the later part of the season, being well advanced and with loose scales were difficult to handle safely.

On the Usk, catches were again very disappointing in spite of the netting programme beginning about a fortnight earlier than it did in 1959, and continuing into early June. Altogether, the net was fished on 45 separate days compared with 25 in 1959. Furthermore, on each occasion the fishing was continued for a longer period. Only 39 smolts were tagged in the freshwater section of the river.

Once again however, smolts were captured at the screen chambers at Uskmouth Power Station situated on the east bank of the estuary about 2 miles below Newport. These operations were continued throughout April, and 806 smolts were tagged and released into the estuary below the Power Station just after high tide. As these smolts were caught so far down the estuary it is not certain, however, that they all came from the River Usk.

The numbers of salmon smolts tagged in the three rivers during the last three years are shown below:—

	1958	1959	1960	Total
River Usk ...	384	585	858	1,827
River Wye ...	333	1,311	3,843	5,487
River Severn .	1,043	669	5,411	7,123
Total	1,760	2,565	10,112	14,437

Recaptures

During the 1960 fishing season three recaptures of tagged fish have been reported:—

1. An $8^1/_4$ lbs. fish was caught in the River Teme (tributary of the Severn) at Powick. It was tagged as a smolt in the River Severn at Gloucester in May, 1958.
2. A $4^1/_2$ lbs. grilse was caught off Oldbury Sands (River Severn). It was tagged as a smolt in the River Severn at Tewkesbury in April, 1959.
3. An 8 lbs. fish was caught in the River Wye at Chepstow. It was tagged as a smolt in the River Usk at Newbridge in April, 1958.

A. Swain

Capture of Pink Salmon on the Scottish Coast

On 16. July 1960, a specimen of the pink or humpback salmon (*Oncorhynchus gorbusha*) was caught in a coastal net at the Altens netting station on the Kincardineshire coast some three miles south of Aberdeen. It was 52 cm long and weighed 1.88 kg. Dissection showed that it was a male in which the testes were developing.

There is reason to suppose that two specimens of pink salmon were caught at a netting station on the Island of Skye and there are unconfirmed reports that one or two pink salmon were taken at a netting station on the south coast of the Moray Firth.

K. A. Pyefinch

German Salmon Fishery in the Baltic in 1960

(Tables 3–6)

The yield of the German salmon fishery in the south-eastern part of the Baltic decreased a little, from 243 tons in 1959 to 217 tons in 1960. Of this quantity, 38.1% were landed in January/June and 61.9% in September/December. In the preceding year, the relation was inverse, 64.4% : 35.6%, but in 1958 it was similar to that of 1960, 43.2% : 56.8%. The annual yield of the German salmon fishery is composed of two parts belonging to different fishing seasons separated by an interruption for 3—4 months in summer. During this time the stock of salmon changes considerably by growth, recruitment and migration. The fishing season 1959/60 yielding 169 tons only, was the poorest one since 1955/56 (140 tons) and much below the average for 1954/60 (231 tons), as shown in Table 3.

The fishing season 1959/60 yielded less than two-thirds of the catches in 1958/59, and the mean catch per trip decreased to the same extent, as the number of trips was equal in both seasons (calculated from the total catch and the data recorded at the Kiel Fish Market). The average weight of salmon fluctuates inversely to the catch, both phenomena being caused by the fluctuations in the salmon stock. The appearance of a rich smolt year-class in the catches as A. 1+ year-old fish was recorded in the autumn of 1954, 1956, and 1958, and also in 1960 as may be seen from the good catches in the last months of that year. It is very instructive to compare the mean catches of 1949/54 with those of 1954/60. The annual yield has increased from 121 to 231 tons, i.e. by 80%, and in nearly the same extent the fishing intensity has risen, from 210 to 380 trips, i.e. by 90%. Also the mean catch per trip increased from 576 to 608 kg,

Table 3. German landings of salmon from the south-eastern Baltic

Fishing season	Mean 1949/54	1954/55	1955/56	1956/57	1957/58	1958/59	1959/60	Mean 1954/60
Total, tons	121	195	140	375	241	267	169	231
Mean catch per trip, kg	576	604	445	885	568	698	448	608
Mean weight gutted, kg	—	4.38	5.33	4.02	4.85	4.27	4.59	4.57
Number of trips	210	320	315	425	425	380	380	380

i.e. by 5.6%. Unfortunately, we have no data for the average weight of salmon in the period 1949/54. In comparison with the mean values for 1954/60, the weight of salmon in 1959/60 and the number of trips were on an average, whereas the total catch and the catch per trip were below normal, by 26—27%.

The fishing season 1960/61 promises to become a very good one. In September/December 1960, the mean catch per trip amounted to 645 kg, and the average weight of salmon was higher than expected, 5.03 kg, due to an excellent growth in its first two years of life in the sea, of the rich 1959 year-class which dominated in the catches.

The monthly landings in 1960 are shown in Table 4 and compared with the averages of the preceding years.

Table 4. Monthly landings of salmon in 1960, compared with the averages for 1955/59 and 1950/54

	1960		1955/59		1950/54	
Month	Tons	%	Tons	%	Tons	%
January	15.5	7.2	39.8	16.2	25.1	19.2
February	15.1	7.0	20.2	8.2	20.4	15.6
March	22.9	10.5	33.7	13.7	16.4	12.5
April	15.2	7.0	20.2	8.3	9.9	7.6
May/June	13.9	6.4	14.4	5.9	3.6	2.8
September	3.2	1.5	—	—	—	—
October	11.5	5.3	9.0	3.7	1.8	1.4
November	55.8	25.7	48.1	19.6	18.3	14.0
December	63.9	29.4	59.8	24.4	35.2	26.9
Total	217.0	100.0	245.2	100.0	130.7	100.0

The fishing season 1959/60 was characterized by maximum landings in November/December and a sudden decline in January. The employment of drift-nets caused increasing catches in March. The trend of the monthly landings is reflected by the monthly catch per trip. It decreased from 533 kg in November 1959 to 357 kg in January 1960, and rose again to 553 kg in March; thereafter steadily decreasing to 251 kg for the last trips finished in the first days of June. The new season 1960/61 started already in September, and with increasing numbers of trips the landings reached remarkable figures in November and December. The mean catch per trip amounted to 645 kg and was surpassed only in the fishing seasons 1956/57 and 1958/59.

Within 10 years, the average annual yield of the German salmon fishery in the Baltic has nearly doubled by intensifying the fishery, and the total catch in 1960 is only a little lower than the average for 1955/60 (Table 4). There is a tendency to extend the fishing season; the landings in the first and last months of the season September/October and May/June have increased from 4.2% in 1950/54 to 9.6% in 1955/60, and 13.2% in 1960.

The size composition of the landings at the Kiel Fish Market in 1960 is given in Table 5.

Table 5. Size composition of salmon landed at the Kiel Fish Market in 1960

Market category	I	II	III	IV	V	VI	Aver.
Gutted weight, kg	>8	7–8	5–7	3–5	2–3	1–2	weight, kg
	Number (%)						
Jan.–Feb.	22.4	10.0	10.6	32.9	20.5	3.6	5.12
March–April	12.3	8.8	9.4	53.2	15.2	1.1	4.49
May–June	8.4	4.1	6.7	59.9	19.9	1.0	4.00
Sept.–Oct.	2.5	4.2	17.1	61.9	14.3	—	4.32
Nov.–Dec.	10.3	6.8	26.8	52.3	3.4	0.4	5.13
Total catch	11.7	7.3	18.5	51.1	10.4	1.0	4.85

In the last two months, the size composition of the landings was quite different from that in the first two months of the year, though the average weight was the same. The percentage of big salmon (>7 kg) was smaller, and those of medium size (3—7 kg) heavily rose, whereas the quantity of small fish was negligible, due to the increased minimum size (60 cm), and the excellent growth of the A. 1 + age-group (1959 smolt year-class). Towards the spring and summer, the average weight of salmon decreased due to a northward migration of big fish, and during autumn and winter it increased again as the remaining fish grew up.

In Table 6 the quantities of each market category landed at the Kiel Fish Market during the two last years is given.

Whereas the poor 1958 smolt year-class (age-group A. 2) caused a heavy decline of the market categories III—V in the last months of 1959, the rich 1959 smolt year-class yielded large quantities

Table 6. Salmon landed at the Kiel Fish Market in 1959 and 1960 (in tons)

Market category	I	II	III	IV	V	VI	Total
Jan.–June 1959	18.7	16.3	21.3	52.5	13.9	0.7	123.5
Oct.–Dec. 1959	16.1	10.0	9.1	13.5	8.0	1.1	57.8
Jan.–June 1960	19.8	8.9	8.0	24.6	6.5	0.4	68.2
Sept.–Dec. 1960	16.4	9.2	27.6	42.3	2.4	0.1	98.0

of medium salmon (size groups III and IV) in the same months of 1960. The landings of big salmon (I and II) do not fluctuate so much; the considerable differences in the yields between the two sections of each year are caused by the fluctuations in the smolt production as rich and poor smolt year-classes have alternated since 1954.

R. KÄNDLER

The Results of Soviet Investigations into the Acclimatization of Pink Salmon (*Oncorhynchus gorbusha*) in the Waters of the Barents Sea and the White Sea

(Figure 1; Tables 7–9)

At the end of June 1960, the first specimens of pink salmon on spawning migration appeared in the inshore waters of the Kola Peninsula. This fact may be interpreted as an indication of a future acclimatization of Pacific salmon in the north European waters. In the second half of 1960, sampling was carried out on migrating pink salmon in order to elucidate the time of the river ascent, the spawning behaviour, and the survival of the deposited eggs in the rivers of the Kola Peninsula.

The length of the pink salmon ranged from 38 cm to 65 cm; information on the mean length and weight is given in Table 7. The data indicate that the mean length and weight of the Kola pink salmon migrating for spawning in 1960 corresponded to those for the Sakhalin pink salmon, which, according to P. A. DVININ, were 48.5 cm and 1.5 kg respectively. Hence the Kola pink salmon do not differ much from the Kamchatka pink salmon (see Table 8). Scale reading showed that all the specimens examined were 1+ year-olds, i.e. they belonged to the 1959 year-class, the same year in which the fish-breeding farms released about 14 million fry into the rivers.

The regions and the numbers of pink salmon migrating into the inshore waters of the Kola Peninsula are shown in Figure 1. In all localities breeding started in the second half of September. The fecundity of the breeders ranged from 1,486 to 2,247 eggs per specimen, amounting to an average of 1,913 eggs. The mean was obtained by counting eggs of 31 salmon caught in the River Umba. Breeding places were found both within short distance from the mouths of the rivers (Titovka, Ura, Voronya, and others), and at a distance of 100 km or more from the sea (the Rivers Umba and Ponoi).

The spawning period of the Kola pink salmon and *Salmo salar* coincide, but their breeding places are separate. Pink salmon spawn at less depth in more shallow, gravelly localities where turbidity is less. The eggs are usually buried at 20—30 cm depth but in the River Kola they were buried at 35 cm depth. The characteristic features of certain breeding places of the pink salmon (depth, character of bottom, speed of the current, and other data) are set out in Table 9.

For observation of the development of the eggs, several pink salmon redds (nests) were marked out on the Rivers Titovka, Ura, Ponoi, and Kola. In the early days of October, when the breeding period of the pink salmon was coming to an end, a rapid cooling of the water took place due to an early onset of winter. The severe temperature conditions and the shallowness of the rivers of the Kola Peninsula in the autumn/winter of 1960/61 made us worry about the future of the deposited eggs. In September 1960 observations on the development of these eggs began. The results of examination of the opened redds are given in Table 9.

The data indicate that the development of the

Table 7. Mean length (cm) and weight (kg) of pink salmon migrants in 1960

Area of sampling	♂♂ Length	♂♂ Weight	♀♀ Length	♀♀ Weight	♂♂ and ♀♀ Length	♂♂ and ♀♀ Weight	Number of specimens
Murman coast and River Ponoi	48.6	1.65	46.8	1.50	47.8	1.55	187
River Pyalitsa	46.2	—	50.1	—	48.1	—	167
River Umba	52.0	1.70	48.5	1.40	49.5	1.60	181

Table 8. Comparison of the size composition of Kola and Kamchatka pink salmon (%)

Area	Size (cm) 34–37	38–43	44–48	49–53	54–58	59–63	64–66
Western Kamchatka	0.17	10.98	63.87	22.70	2.20	0.08	0.00
Kola Peninsula	0.00	11.10	46.65	34.80	6.05	0.85	0.55

Table 9. Characteristics of the breeding places of pink salmon and development of the eggs in the redds (nests) in 1960–1961

River	Date of end of spawning (1960)	Water-temperature (° C)	Depth (cm)	Date of opening of redd (1960/61)	Thickness of ice (cm)	Layer under ice (cm)	Number of eggs	Stage of development	% of eggs alive	Remarks
Umba	20.–30. Sept.	8.8–5.2	About 70	12. Dec.	15	25–35	277	Pigmentation of eye	91.4	Ground in all places shallow with middle-size gravel, current speed (during breeding period) 0.45–0.80 m/sec.
Umba	20.–30. Sept.	8.8–5.2	About 70	12. Dec.	15	25–35	402	Pigmentation of eye	9.2	
Umba	20.–30. Sept.	8.8–5.2	About 70	14. Feb.	No ice	25–35	400	Devel. abd. fin	43.0	
Umba	20.–30. Sept.	8.8–5.2	About 70	14. Feb.	No ice	25–35	250	Devel. abd. fin	44.0	
Vjala	20.–30. Sept.	8.8–5.2	80	14. Feb.	40	20	150	Devel. abd. fin	0.0	
Porja	2. Oct.	3.8	40	9. Feb.	3–4	80	50	Devel. abd. fin	88.0	
Kola	5. Oct.	2.8	45	3. Mar.	No ice	25–35	238	Heart pulsation	50.0	
Titovka ..	23.–30. Sept.	5.0–10.0	30–50	19. Jan. 15. Mar.	10–30	0.0–90.0	4,000	No eggs alive	0.0	Perishment of eggs due to freezing of the ground owing to insufficient current
Ponoi	28. Sept.	4.0	50	29. Mar.	70	30	517	Mobile embryo	91.4	
Ponoi	22. Sept.	7.4	20	3. Apr.	15	10	475	No eggs alive	0.0	

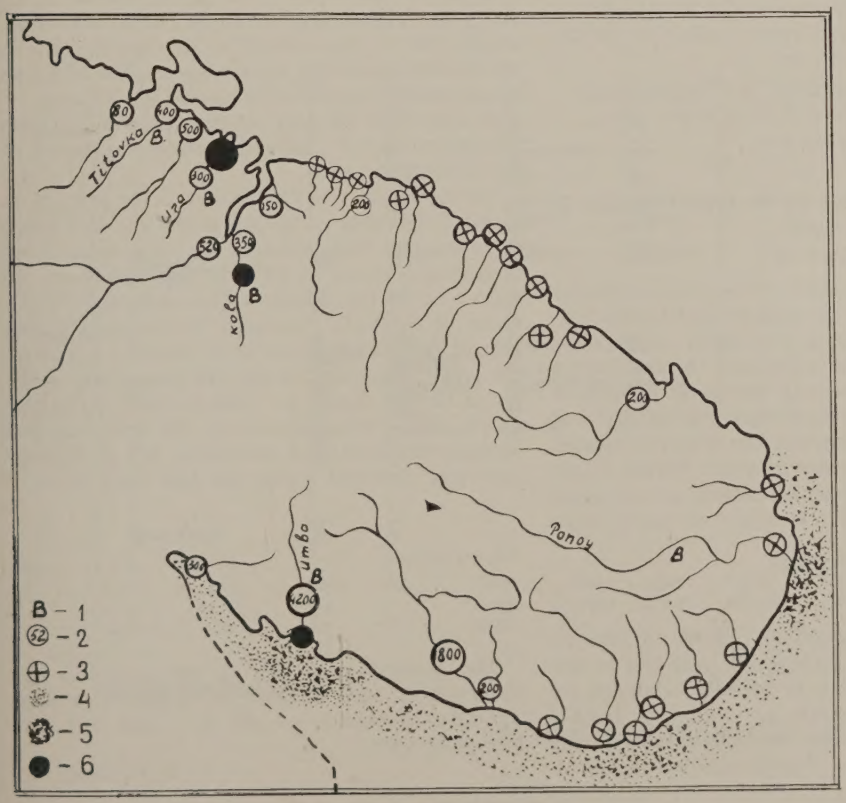

Figure 1.

Chart of pink salmon distribution in the water basin of the Kola Peninsula.

1 = breeding places
2 = number of fish observed
3 = rivers where pink salmon were observed
4 = places of catch of pink salmon with set-nets at sea
5 = places of largest catches of pink salmon
6 = hatcheries

eggs was proceeding normally in the majority of the breeding places situated in the rivers falling into the White Sea. Death of the eggs was only observed in the early stages of their development and was obviously caused by the same factors which are at work in the Far Eastern breeding places. The number of eggs survived also approached that of the Far East. Only in the River Titovka (western Murman) not a single redd was observed with eggs alive. The reason for the death of the eggs may apparently be explained by the character of the hydrographic conditions during the incubation period. Information from the scientific staff of the Murmansk Marine Biological Institute shows, however, that conditions similar to those observed in the River Titovka exist in the River Muchka (the basin of the River Titovka). Egg mortality was also high there, but a certain amount of normally developing eggs were found in that place; therefore we cannot explain the death of the eggs in the River Titovka by the peculiarities of the ground and the temperature conditions.

These investigations testify to the fact that pink salmon are able to breed under Kola Peninsula conditions, but final conclusions can only be drawn after observations have been conducted on the descend of the fry to the sea.

V. V. Azbelev, E. L. Bakshtanski,
S. S. Surkov, R. S. Khusin, and
M. Y. Yakovenko

Results of Investigations on the Kola Peninsula in 1960

(Table 10)

The present development of the salmon fisheries in the Kola Peninsula is characterized by the tendency to restrict, by 50%, the capture of breeders migrating to the spawning grounds. This is achieved by organizing fish passes in the lower reaches of certain rivers, and by restricting the fishery and counting the salmon entering the rivers in regions with well developed marine fisheries. During recent years the yields of the salmon fishery, as compared with the long-term mean reckoned as 100%, have been as follows:—

1955	1956	1957	1958	1959	1960
96.0%	60.0%	59.5%	73.0%	73.0%	144.0%

The high yield obtained in 1960 is not due to changes in the fishing methods or gear but to the entry of a large number of recruits belonging to younger age-groups, mainly 4_3+ and 5_4+. In this connection the proportion of small salmon taken in coastal waters of the Barents Sea has increased from the usual 6.0—17% to 30% and even 50% in certain rivers. In the coastal area of the White Sea where salmon which have spent one year in the sea are prevailing we found the usual conditions. The total number of fish of the 3_2+, 4_3+, 5_4+, and 6_5+ age-groups constituted there 74.0—95.0% of the annual catch.

The percentage distribution of the age-groups migrating to the spawning grounds in 1960 is given in Table 10.

Table 10.

Areas	Age-groups 3+	4+	5+	6+	7+	Repeated spawners
River Ponoi	0.8	36.8	36.8	18.1	4.4	3.1
Rivers Pyalitsa/ Chavanga	8.3	61.4	17.9	11.8	0.5	0.1
River Varzuga ..	0.8	72.7	24.6	1.9	—	—

Owing to the large recruitment of 4+ specimens the average weight of the salmon appear to have dropped in the greater part of the fishing areas. In the rivers of Western Murman the average weight of the salmon was 4.2 kg instead of the usual 5 to 7 kg, in the Kola Bay it was 3.5 kg instead of 4.5 to 5.5 kg, in the area of the River Ponoi the average weight was 2.7 kg instead of 3.2—4.0 kg, and in the Kandalaksha Bay an average weight of 3.2 kg was registered instead of the usual 4.0—5.0 kg.

As a result of the great number of young recruits the percentage of repeated spawners appeared to be very low in 1960.

During recent years a decrease in the proportion of fish descending to the sea at the age of 2 years, together with an increase in the proportion of fish migrating seaward at an older age have been observed in all the salmon stocks migrating to the rivers of the Kola Peninsula. In the main fishing area of the coastal waters of the Barents Sea where the usual proportion of the fish descending to the sea at the age of 2+, 3+, and 4+ made up 23.0%, 75.0%, and 2.0% respectively, the following percentage distribution of descending fish at different ages was observed during the last three years:—

Year of capture	Age-groups 2+	3+	4+	5+
1958	17.8	77.5	4.6	0.1
1959	3.7	86.1	10.2	—
1960	1.1	75.4	23.2	0.3

The abundance of fish at age 4_3+ and 5_3+ observed in 1960 enables us to expect a large quantity of salmon of the 5_3+ and 6_4+ age-groups in 1961.

V. V. Azbelev

Shellfish

MOLLUSCA

Oyster

Larvae and Spatfall of Oysters in the Oosterschelde (Netherlands) in 1960

(Figure 1)

Spatfall prediction based on analysis of plankton samples was continued in 1960. No changes were made in the methods of collecting the plankton samples or of counting and measuring the larvae. Daily samples were taken at high slack water from 13. up to 20. June inclusive, twice-daily samples at high slack water and low slack water in the height of the season from 21. June to 5. August inclusive. From 6. to 30. August, samples were collected at high slack water only. Again, it was impossible ot collect plankton samples on Sundays when the boats stayed in port. When two samples were taken a day, the average number of larvae has been computed for 100 litres, and is depicted in the diagram (Fig. 1). The intensity of setting was measured in the usual way by exposing 3 lime-coated glass slides, measuring 13 × 18 cm, at an angle of 45° in a concrete container, for periods of 3 days. The average number of spat per slide is shown in the diagram. The average number of barnacles found on 10 cm² of the slides (5 cm² upper + 5 cm² lower surface) is also shown.

The first bulletin, issued 21. June, informed the oystermen that the total number of larvae to be expected would again be so great that only continuous adverse weather conditions would lead to a poor spatfall. Further, that several hundreds of oyster larvae were already counted per 100 litres

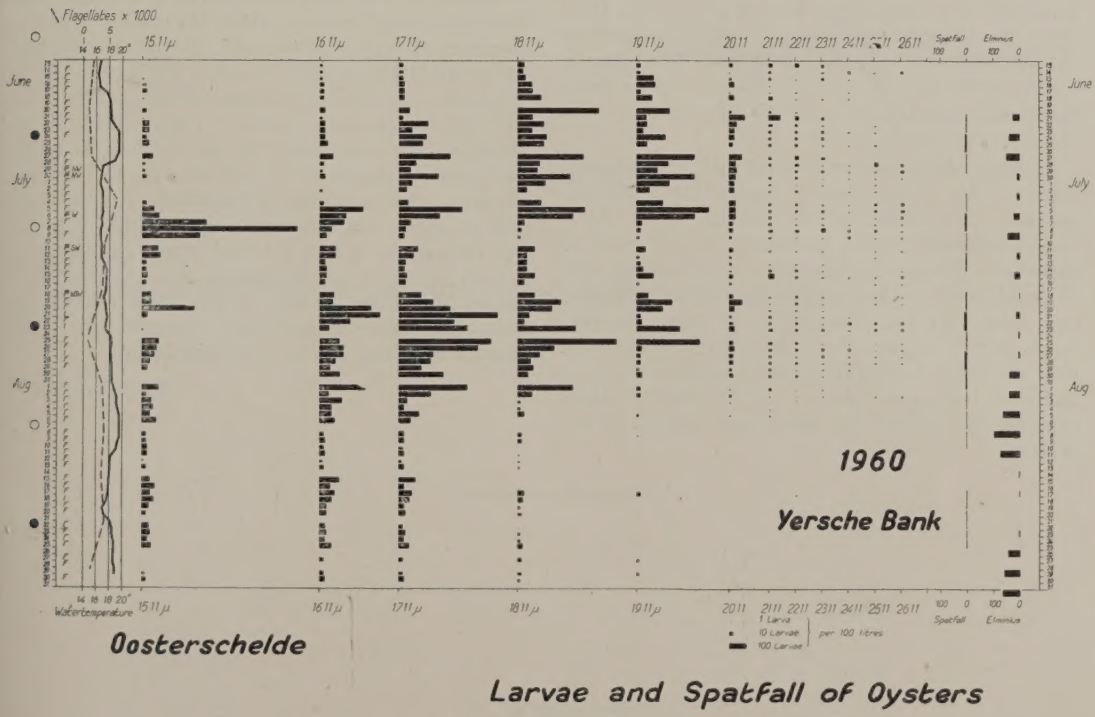

Figure 1.

of water, but only larvae in an early developmental stage. On 23. June it was broadcast that the number of oyster larvae was increasing and that slightly higher water temperatures led to a fairly good larval development. The observation of the first "umbo" larvae indicated that the very first spat could be anticipated in the days to come. On 29. June it was stated that the number of larvae remained at the level of 400 per 100 litres of water and that the increasing number of "umbo" larvae allowed announcement of a setting of commercial importance.

A serious drop in water temperature to about 17° C — too low for normal larval development — was recorded in the bulletin issued on 2. July. Since the number of "umbo" larvae was on the decline, setting prospects were said to be poor. Continuation of the low water temperatures, rendering larval development impossible, was recorded on 9. July. On 15. July the water temperature was said to remain at about 17° C; the total number of larvae having declined to about 100 per 100 litres of water, and "umbo" larvae being absent, spatfall prospects were very poor indeed.

An increase in the number of larvae to about 1000 per 100 litres of water was recorded on 20. July. Since the water temperature had not yet surpassed the critical level of 17.5° C, larval development continued to be very poor. "Umbo" larvae being found only sporadically, spatfall was announced to be of a very scanty nature.

A slight rise in water temperature, immediately followed by a somewhat better larval development, was stated in the bulletin of 25. July. It was then said that a sprinkling of spat could be expected. Though the number of larvae was said to decline on 30. July, a light spatfall was announced, based on the observation of some "umbo" larvae in the samples. On 4. August it was recorded that the water temperature had increased to 19° C, but that large and "umbo" larvae were so scarce that no spatfall of any importance could be expected.

Since no amelioration in setting prospects could be announced after that date, no further bulletins were issued.

The diagram (Fig. 1) reveals that the total number of larvae produced has been great, indeed, though slightly less than in 1959. The time of their appearance can be considered normal. Again, the larvae of the first batches, liberated in June, were of a larger size than the larvae set free in July and August. Again, peaks in larval production made their appearance according to the lunar periodicity pattern, in the month of July about 12 instead of 10 days after full and new moon, which tallies very well with a prolonged incubation period caused by the low water temperatures. Conspicuous is the paucity of larvae in the middle of the month of July. The scarceness of oyster larvae after the first few days of August is a normal phenomenon.

The number of large and "umbo" larvae depicted in the diagram demonstrates that larval development has been unusually poor throughout the summer season of 1960, so that the discouraging bulletins had a sound basis. Spatfall has been very much poorer throughout the summer season than in any other of the post-war years. For the first time since many years, spatfall has been a complete commercial failure. Only part of the lime-coated tiles were placed, despite the poor setting prospects. Of those, only the first batches placed late in June, received a reasonable number of spat. Water temperatures were unusually low for too long a period and higher temperatures came too late to save the situation. The number of flagellates counted per cm^3 of water was somewhat higher than in 1959; but during the weeks in which their number surpassed 2000 per cm^3, indicating good feeding conditions for oyster larvae, it was unfortunately so that either water temperatures were too low or the number of oyster larvae was insignificant.

P. Korringa